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AND
ILLUMINATION

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School Lighting (Modern Requirements and Recent Progress)

On pp. 173-178 we reproduce the admirable paper on the above subject read by Dr. James Kerr before the Illuminating Engineering Society on April 29th, together with the ensuing discussion. Dr. Kerr, as the late School Medical Officer for London, has had many opportunities of studying this subject, and it will be recalled that he acted as Chairman of the Joint Committee of the Illuminating Engineering Society which issued a report on the subject shortly before the war. This report may be considered one of the earliest efforts to formulate the general principles of school lighting. Whilst there have been notable advances in lighting since that date, and the moment was therefore ripe to review progress and consider any desirable modifications in the original report, the discussion showed that its contents has stood the test of time remarkably well. The general principles then laid down are in substantial agreement with those endorsed to-day, as well as those expressed in the schedule put forward by Mr. L. B. Marks at the Geneva meeting of the International Illumination Commission (see p. 169).

There are only two chief respects in which Dr. Kerr suggested modifications. The general standard of interior lighting has risen considerably since 1914, and the introduction of more efficient illuminants, both gas and electric, has rendered practicable higher illuminations than were customary before the war. Even at that time there was a feeling on the part of some members of the Committee that somewhat higher illuminations should have been recommended, and that not less than 3 foot-candles should be provided. Dr. Kerr suggests that a range of 5-7 foot-candles should now be regarded as the desirable provision for desk illumination in schools.

The second modification is based on the recognition that the more efficient illuminants now in use possess a considerably higher intrinsic brilliancy, and that therefore the avoidance of glare has become a particularly vital matter. Dr. Kerr therefore recommends the limitation of the brightness of lighting units placed within the normal range of vision.

Several other points were emphasized in the discussion. One found, for instance, a general recognition of the difficulty in securing proper cleanliness and maintenance of lighting units. Unless regular supervision can be ensured, fittings of a type liable to collect dust should be avoided. Open bowls are notoriously troublesome in this respect, and units of the totally enclosed diffusing type are doubtless preferable. Dr. Kerr also laid special stress on the efficient illumination of blackboards. The original report of the Joint Committee took a far-sighted view—somewhat in advance of that expressed in some other recommendations—on this matter. It contained a provision that the illumination on the blackboard should be 40 per cent. in excess of that over the desks. This extra illumination is desirable in order to focus the attention of scholars, and also because the distant inspection of diagrams (often executed in coloured chalk) on a blackboard is a somewhat fatiguing process. Apart from the standard of illumination, the nature of the blackboard surface and the arrangements of the sources illuminating it are important.

Yet another highly interesting point raised in the final portion of Dr. Kerr's address is the effect of the *colour* of light used in the case of close vision. Some investigators have formed the impression that the difference in the spectrum of ordinary illuminants, which contains an excess of yellow and red rays as compared with daylight, is liable to cause visual fatigue, possibly owing to some difference in the ease of accommodation of the eye. A source of light generally resembling daylight in colour value was found to be more restful in this respect. This is obviously a matter which deserves fuller investigation, with the co-operation of ophthalmologists and physiologists, especially in view of its possible application to the treatment of children who show a myopic tendency.

School lighting is essentially a subject which can only be properly studied with the aid of the user of light. On the Joint Committee formed by the Illuminating Engineering Society medical and educational bodies concerned with the subject were fully represented. It was very gratifying to observe at the meetings a number of medical officers for schools and teachers, and especially to have the presence of Dr. E. H. Nash, who, besides being a member of the Committee formed by the Illuminating Engineering Society, is likewise the Chairman of the Committee on "The Ideal Classroom" recently created by the Medical Officers of Schools Association. (Of this Committee, which has been working in co-operation with the Illuminating Engineering Society, Dr. J. Kerr and Mr. L. Gaster are also members.) As the Chairman of the latter body Dr. Nash has been intimately interested in the study of school lighting for many years, and it was a very suitable arrangement that he was able to preside over the discussion of Dr. Kerr's paper.

In such a discussion it is right that all viewpoints should be expressed, and it was not surprising to find that some of the teachers and medical officers voiced the difficulty sometimes experienced in persuading authorities to sanction the cost of better

lighting. Educational institutions are not, as a rule, in the possession of large funds, and naturally have to consider ways and means. At the same time, we are in full agreement with the view generally expressed at the meeting that, in view of the vital importance of good lighting to the health and vision of the children of the nation, the question of cost ought not to stand in the way of providing proper lighting facilities. The cost of lighting forms but a small fraction of the total overall cost of education. A small increase, therefore, cannot affect the total expenditure appreciably, yet it makes all the difference to the efficiency of the educational process. It is, for instance, useless to expect children to learn quickly from books which are insufficiently lighted, or to pay close attention to sketches or lettering on a blackboard which are indistinct. Improvement is largely governed by the education of public opinion. If the nation can be got to realize the fundamental importance of furnishing adequate lighting in the schools the necessary funds will be found.

Research on Illumination

IN our last issue we included the Free Report issued by the Illumination Research Committee of the Department for Scientific Research, giving a preliminary survey of the work of this Committee.* This account has since been supplemented by the paper read by Mr. J. W. T. Walsh, a member of the Committee, before the Illuminating Engineering Society on June 1st. We shall be dealing with Mr. Walsh's paper and the ensuing discussion in our next issue. On this occasion we only propose to offer a few general comments on the work of the Committee. The introductory "Free Report" was, we think, drafted in a manner somewhat different from the ordinary run of Government publications, a good feature being the readable introduction in which the origin of the Committee is traced, and the main principles underlying its work are set out. This was a necessary and a valuable feature, because the work of this Committee is not merely of technical interest, but has a vital bearing on daily life. Such questions as the influence of illumination on the speed and accuracy of work and the influence of glare are of moment to all members of the community. The wisdom of this introductory explanation has been justified by the wide publicity which the report has already received in the daily and technical press.

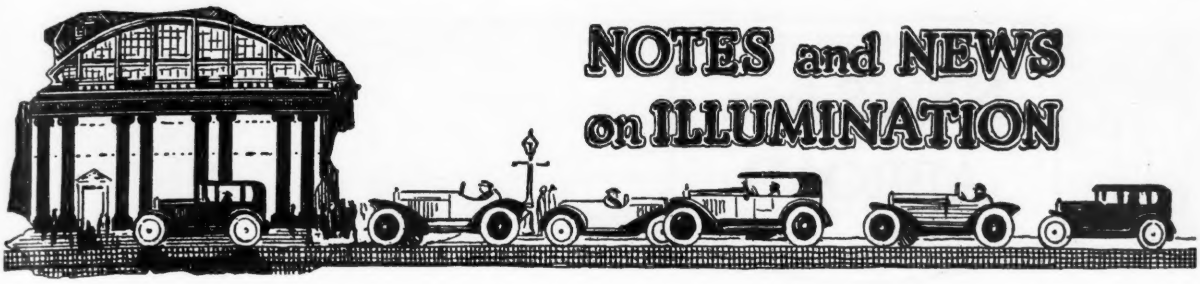
Mr. Walsh's paper before the Society also contained a lucid and comprehensive survey of the Committee's work, one of the main points emphasized being the distinction between "fundamental research," dealing with principles underlying all lighting problems and "practical problems of urgency." The former naturally takes a considerable time, though results once secured are extremely valuable: the latter frequently leads quite quickly to useful results, though its bearing is more confined.

The exceptionally representative nature of the Committee was indicated in the introductory "Free Report." It includes amongst its members lighting experts, architects and medical men, the latter being representatives of the Medical Research Council, whose co-operation in many of these fundamental problems—which involve consideration of the effects of light on vision—is essential for their proper solution. The various members of the Committee were selected in order that all the chief *aspects* of illumination might be represented. It was naturally impracticable to include representatives of all the various bodies concerned with illumination, though the members of the Committee are themselves in close touch with all the chief committees and societies interested in lighting problems. For instance, various members of the Committee are also members of the Illuminating Engineering Society, of the Home Office Committee on Lighting in Factories and Workshops, and of the B.E.S.A. Committees concerned with illumination. In the National Physical Laboratory the Committee has available an admirable institution for the carrying out of experiments, and it is also in close touch with associations abroad engaged in research in illumination.

Between all these and other organizations interested in lighting problems the Illuminating Engineering Society acts as the "liaison officer," and supplies the connecting link. It acts as a clearing house for information on illumination, thus helping to prevent overlapping of work and bringing together experts working independently in various fields of knowledge. There are some researches which the Illuminating Engineering Society itself can undertake. There are also others which can best be allocated to bodies having a special individual interest therein. And there are many important problems, such as may be classed under "Fundamental Research" which are of such moment to the community that they can only be dealt with by a thoroughly impartial representative and authoritative body of experts uniting the efforts of those associated with all the various aspects of illumination. The researches being undertaken by the Illumination Research Committee and the various B.E.S.A. committees are exactly those with which these committees are most competent to deal. It is no secret to say that the existence of all these committees is due very largely to the influence of the Illuminating Engineering Society and the personal efforts of some of its leading members. The field for research in illumination is too wide for any single body—even the Illuminating Engineering Society—to deal with unaided. Hence it is a natural development that the Society should now be acting mainly as the inspirer of research, and its members should appreciate at its true value the sympathetic and far-sighted action of the Department for Scientific and Industrial Research in forming the Illumination Research Committee and rendering possible the study of these fundamental problems.

The other chief function the Society is performing is in facilitating the discussion of the results of these researches and causing them to be more widely known. It is an anomaly that so often the valuable work of committees is overlooked by those most in need of it. It would be a poor reward for the ungrudging services, rendered in an honorary capacity by members of the Illumination Research Committee and the B.E.S.A. Committees, if the Society did not do all in its power to ensure that their work received due attention. It was partly this consideration that led to the discussion, on the Society's platform, of the work of the various B.E.S.A. Committees dealing with illumination. The discussion of the preliminary account of the work of the Illumination Research Committee has, we believe, been equally useful, and we hope that the reports of individual researches, when they are published, will likewise be the subject of discussion at the Society's meetings. In general, the issue of a report marks the termination of the activities of a Committee. It is only through the existence of such a body as the Illuminating Engineering Society that this work can be reviewed and applied, and, if necessary, modifications suggested to meet new conditions. The initiation of such discussions is, therefore, one of the most useful educational functions which the Society can perform.

* *Illuminating Engineer*, May, pp. 139-141.



Glare and Contrast

Simple rules for the avoidance of glare, based on limiting the brightness of glassware, etc., to a moderate value—for example, 3-5 foot-candles per square inch, which is somewhere about the average brightness of a white sky—have been widely recommended and frequently adopted in dealing with practical lighting problems. But it is now generally understood that glare is very often a matter of contrast, and cannot be entirely avoided, even with objects of very moderate brightness, if the eye is exposed in succession to widely different conditions in this respect. The impression received by the eye depends much on its previous experience. A person coming into an artificially lighted building from the dense darkness of a country road at night is inevitably dazzled. Some time is necessary for the eye to become adapted to the new conditions. It is recognized that the driver of a railway train, tramcar, or motor vehicle who has to gaze into the darkness ahead, should not work in a brightly lighted compartment; indeed, some consider that this apartment should be unlighted except for the low illumination of shielded lights necessary for the observation of gauges or instruments. Similar considerations apply to operations in a signal-box. It has also been suggested that means should be taken to lessen the abrupt change in brightness when a train passes out of the dark tunnel into the sunlight outside. From this standpoint even the comparatively low illumination in stations of tube railways deserves consideration. A somewhat similar problem occurs in the case of passengers descending rapidly underground by escalators and lifts. Up-to-date kinema theatres try to ease the transition from the brightness out of doors to the darkened auditorium by grading the illumination in steps. Something similar occurs on tube-railways, but in this case passengers are whisked underground more rapidly. Hence the time before they arrive in the tube may not always be sufficient for complete adaptation.

Institution of Public Lighting Engineers

We are informed that Mr. Alexander C. Cramb, M.I.E.E., M.I.Mech.E., Engineer and Manager, County Borough of Croydon Electricity Department, has accepted the invitation of the Council of the Institution of Public Lighting Engineers to take the office of Vice-President with a view to becoming President of the Institution in 1927, when the annual meeting and conference will be held at Brighton.

E.C.A. Allied Associations
First Annual Conference

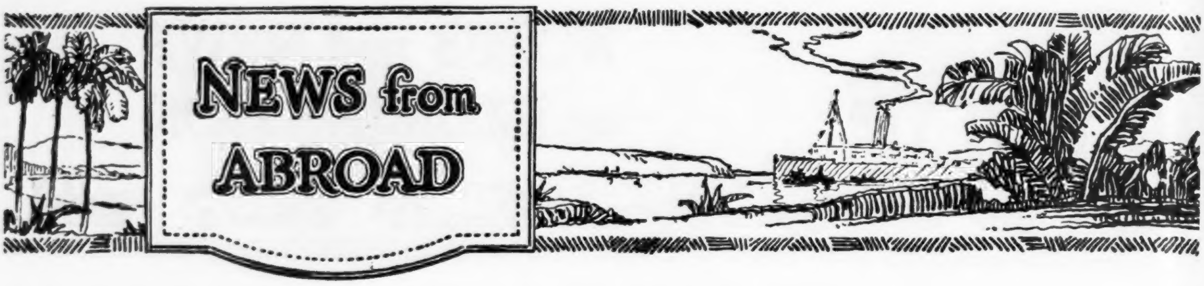
A new departure is being made by the Electrical Contractors this year in the holding of the first Annual Conference in Brighton during June 23rd-25th. This issue goes to press before the date of the conference, but we note that there are numerous interesting items, including the address of the President (Mr. T. E. Algar), and papers on " Co-operation Between the Supply and Contracting Sections of the Industry " (Mr. Walter Finlay), " Apprenticeship " (Mr. Walter Riggs), " The Need for a Standard Set of Rules to be Applied Nationally " (Mr. Ll. B. Atkinson), and " The Registration of Electrical Contractors " (Mr. F. W. Purse) An address of welcome will be presented by the Mayor of Brighton, and there will be a reception, smoking concert, ball, and other social events.

Meetings of Gas Engineers

Owing to the coal strike, the annual meeting of the Institute of Gas Engineers, originally fixed for June 8th-11th, has been postponed, but the address of the President, Mr. Chas. F. Botley, has been published in *The Gas Journal.* Reference is made to the important question of education. It is encouraging to note that an increase of 60 per cent. in internal and external students of gas engineering and supply is recorded, though larger numbers are still desired and special measures are suggested for the encouragement of students. Research has been proceeding under Professor Cobb at Leeds University, some of it of special moment at the present time. Whilst much of the address is naturally occupied with fuel problems, which bulk so largely in the public mind at present, we are glad to see that the importance of not neglecting the lighting side of the gas business is emphasized. It is pointed out that there never was a time when a greater variety of efficient and artistic fittings were available, whilst in regard to public lighting it is recalled that 75 per cent. of the public lighting of the country is still done with gas. The annual general meeting of the Society of British Gas Industries is being held on June 23rd, whilst at the annual meeting of the National Gas Council, which opened on June 1st, various important questions affecting the future of the gas industry were discussed. Amongst these were proposals for facilitating amalgamation of the less efficient gas undertakings, or the bulk supply of gas to them by larger and more powerful concerns, and the possibility of a more scientific "two part " tariff system of charging. Whilst so much attention is being bestowed on proposals for developing electrical supply the changes that are being initiated in the gas industry should not be overlooked.

The I.M.E.A. Convention

The I.M.E.A. Convention is being held this month at Glasgow (June 15th—18th). The three papers to be read deal with " Supplies to Outlying Districts " (Mr. S. E. Britton), " Operating Costs of Electric Battery Vehicles " (Mr. C. W. Marshall), and " Industrial Electric Heating " (Mr. A. P. M. Fleming and Mr. J. H. Crossley). The latter is a specially informative contribution, and the other two papers also deserve study. There is thus no paper dealing specifically with illumination this year, but no doubt in 1927 the relation of illuminating engineering to supply undertakings will receive more attention. At the Convention last year lighting figured prominently, and the general feeling was that the future of electric supply depended largely on methods of impressing on the public the benefits of good illumination. The paper by Mr. Fleming and Mr. Crossley, mentioned above, shows what great results have attended the co-operation of supply undertakings, electrical manufacturers and industrial consumers in the United States in connection with electrical heating. In the lighting field the need for such co-operation is, if anything, even more evident.



A Survey of Shop-Window Lighting in Germany

In our last issue we gave a summary of an interesting survey of lighting of shop windows undertaken in Germany.

A comparison of these data with those obtained in England would no doubt reveal some interesting results. At the same time it is not clear whether they are in all respects properly comparable. The method of judgment is somewhat different; it seems doubtful whether the data obtained in Germany related to " retail shops," as evidently in some cases a number of windows belonging to one concern, and presumably in the same building, were examined. However, in Germany, as in England, the number of shops considered to have really good lighting is very small. As might be expected, the types of shops that show best in the one investigation are not always those that are rated most highly in the other. In the German table the jewellers' shops come first of all; in this country this could hardly be the case on the basis of results at present available, owing to the frequent practice of using bare filaments amongst the goods. In both investigations, however, boot shops and tailors' seem to come out well.

It would, evidently, require a very comprehensive and detailed survey indeed before one could definitely place the various types of shops in a country in order of merit as regards lighting. On one point at least we may expect to find general agreement—the proportion of shops of the retail class which have really well-lighted windows is still much lower than it should be.

In most of the chief cities of the world considerable advances in the lighting of the large and important stores have been made. It is mainly in the smaller shops that improvements are necessary.

The Problem of Street Lighting

The recent paper by Herr Wissman on the above subject, to which attention was drawn in our May issue, has, called forth a rejoinder from Herr Heyck, who opposes the view that uniformity of illumination in a street is of no consequence, and that concentrating reflectors (*Tiefstrahler*) should be used. Although it may be true that the eye, looking down a street, is apparently unaware of considerable variations in illumination (provided the transition is *gradual*), it does not follow that a low illumination midway between lamps is not a grave drawback. When a driver is actually approaching such regions a very low illumination must make it more difficult to see objects ahead. Herr Heyck therefore contends that one of the dominant aims in street lighting should be even distribution, the avoidance of a piling up of illumination immediately under lamps, with a corresponding weak illumination midway between them. One of the strongest arguments used by advocates of opaque reflectors of the concentrating type is the elimination of glare. Herr Wissman expressed the view that with so-called extensive units (*Breitstrahler*), giving the necessary high candle-power at angles slightly below the horizontal, some degree of glare cannot be avoided. Herr Heyck, however, contends that this is not true of properly designed units; for example, the latest form of Holophane street lantern, especially if equipped with a light satin finish for the outer surface. The same applies to the Dia-Carbone flame arc lamp with a satin-finished outer globe. Evidently the relative merits of concentrating and extensive units for public lighting are being keenly debated abroad, and it is well that the subject should be thoroughly ventilated.

Comparisons between Lighted and Unlighted Highways

We referred in our last issue to an interesting series of photographs presented in the United States by Mr. F. C. Taylor, illustrating the advantages of lighted over unlighted highways from the motorist's standpoint. The matter has been taken up by Mr. L. D. Rowell, of Purdue University, who, in a letter to *The Electrical World*, contends that such photographs are liable to be misleading, as the plate may not reproduce exactly what is seen by the eye. Most motorists, he suggests, experience relief when they pass from the brilliantly lighted city highways to country roads, which receive little artificial light. This he attributes mainly to the glare from unshaded street lamps, as used in large cities. " If we are to have lighted highways," he suggests, " it is imperative, first, that the sources be entirely concealed, or mounted so high as to be outside the range of the motorist's vision; second, that they be spaced sufficiently close to illuminate all the highway and to make headlight unnecessary." The problem of interpreting photographs of lighting installations is a familiar one. Doubtless the correctness or otherwise of a photograph depends on the skill of the photographer (and naturally his good faith must also be assumed !). As regards Mr. Rowell's comments on street lighting, these appear merely to assert the two fundamental principles, avoidance of glare and uniformity of illumination, which have long been accepted by experts. The difficulty is that at present some compromise between the two seems inevitable. This is well illustrated by the discussion that has been proceeding in Germany between Herr Wissman and Dr. Heyck, alluded to above. A few weeks ago a writer in *The New Statesman* expressed views very similar to those of Mr. Rowell. It is refreshing to find the drawbacks of glare becoming so keenly realized—doubtless one result of the fact that motorists now form a much larger proportion of the population. In future street lighting authorities will find it necessary to take this point into serious account.

Miners' Nystagmus and Inadequate Illumination

The causes and treatment of miners' nystagmus, which were the subject of much discussion in this country a few years ago, have recently been dealt with by Dr. R. Pittar in giving evidence before the Royal Commission of New South Wales, which is considering questions affecting the coal mining industry. In some respects, for example, in suggesting that the cramped posture and errors of refraction are predisposing causes, his evidence is considered to be somewhat at variance with the views of experts in this country. But in asserting that defective illumination is the main cause of the trouble Dr. Pittar is in agreement with the general opinion of medical men and ophthalmic experts, as expressed in the discussion of Dr. Llewellyn's paper before the Illuminating Engineering Society about six years ago.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

School Lighting (Modern Requirements and Recent Progress)

(Proceedings at the Meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 7 p.m. on Thursday, April 29th, 1926.)

A DISCUSSION on the above subject took place at the House of the Royal Society of Arts (18, John Street, Adelphi, London, W.C.), at 7 p.m. on Thursday, April 29th, 1926, when an introductory paper was read by Dr. James Kerr (late School Medical Officer for London). Dr. E. H. Nash (Medical Officer of Health, Hounslow, and Chairman of the Joint Committee on The Ideal Classroom, formed by the Medical Officers of Schools Association), presided.

The minutes of the last meeting having been taken as read, the HON. SECRETARY announced the name of the following applicant for membership:—

Associate Member—

Shaw, Hartley.........Ophthalmic Optician, Imperial Chambers, 17, Bridge Street, Bradford.

The names of applicants presented at the last meeting of the Society were read again, and these gentlemen were formally declared members of the Society.*

The CHAIRMAN then called upon Dr. Kerr to read his paper. It was recalled that the reports on the natural and artificial lighting of schools had been issued in 1913 by the Joint Committee appointed by the Society to deal with this subject. It was felt that the moment was opportune to review progress since that date and discuss further developments. Accordingly, Dr. James Kerr, the Chairman of this Joint Committee, had been approached, and had kindly consented to open the discussion. As on the former occasion when the Society dealt with this subject, the co-operation of the Medical Officers of Schools Association and of the various educational bodies interested had been invited. The Chairman himself (Dr. Nash) was present as the representative of the Medical Officers of Schools Association.

Dr. Kerr's paper was as follows:—

School Lighting (Modern Requirements and Recent Progress)

By JAMES KERR, M.A. M.D.

(Late School Medical Officer for London).

We discuss school lighting once more because a fifth of the population spend many hours daily in school. The Society has also a special interest in the subject, on which knowledge had been gained slowly, bit by bit, for a generation. Education authorities had begun to be interested. Reports had been published by London school doctors, and by a Boston School Committee, but this Society first undertook a comprehensive survey of the whole subject. Our Joint Committee was appointed in 1911, and gave an interim report on Artificial Lighting in the summer of 1913. An interesting discussion on Natural Lighting raised in a paper by Mr. Waldram in the winter following, focussed the subject, and the Committee reported on Natural Lighting of Schools in July, 1914.

The past dozen years, with all their record of high endeavour, have produced a great change. There is an altered outlook. Our standards are different. In social affairs of common interest our aims are no longer to find a minimum: we seek an optimum. On school lighting we may again think it desirable to make recommendation.

Natural Lighting.—The daylight report of 1914 was a complete statement scarcely now requiring amplification. It brought out the value of relative photometry, and defined the minimum permissible illumination of a schoolplace as 0·5 per cent. of the unrestricted illumination of the complete sky hemisphere, or in other words 1 per cent. of the outside window-sill illumination; a "sill ratio" of 100 : 1. Time has merely confirmed the conclusions as to daylight.

This report first set out the enormous importance of the light adaptation of the eye as the underlying element in comfort. This has to be kept in memory with schemes of artificial lighting, as adaptation may easily become the chief factor when there are considerable and rapid variations in light distribution. It is for this reason that an illumination which indoors is brightness may be complained of as darkness by the open-air class scholar.

The Natural Lighting provisions of this report should by now have been fully included in all school regulations.

One other point—not a matter of lighting, but in view of post-war discoveries of the enormous stimulating nutritional effect, especially on the younger children, of the short wavelengths lying between 300$\mu\mu$ and 310$\mu\mu$ in the ultra-violet, but which are stopped by window glass—the upper parts of windows should be kept open as much as possible, and even the provision of specially transparent glass for the upper parts of the windows, of which the so-called "vita-glass" is typical, should be considered as soon as it comes within the range of reasonable cost.

Artificial Lighting.—Since our reports a great range of valuable exploratory work has been carried out by American workers, in the N.E.L.A. Laboratory for instance. At least half a dozen lighting codes have been published by different states. The most important for our purpose is the American code for school illumination recognized by the Illuminating Engineering Society there, dated June 1924.

We had the benefit of their reports at Geneva and were able to accept them as valuable suggestions for guidance rather than standards for regulations. Light is like warmth. Within certain limits the more you get the more you want. American ideals for warming of rooms has crept up to 70° or 80° F. and one sometimes

* *Illum. Engineer,* April, p. 101.

thinks their illumination ideals are following a similar course.

With even distribution of daylight there does not appear any very startling difference to the student's perception between working in school with five, fifty or five hundred foot-candles on the desk. Ordinary daylight is not a standardized product, but it hovers round a rough average proportion of colour, and possibly except for colour variations there seems no sharp limit to brightness of light if it is as evenly distributed as daylight.

Our Committee suggested as the minimum artificial illumination of any schoolplace at least 2 foot-candles. Some members wished a higher limit of 3 foot-candles. I am ashamed to say that I was one of the economists in this case. Further experience of children's vision has probably widened the outlook.

Children's Vision.—The psychology of a child, especially a young child, is to be regarded. Actual school observations show that there is a considerable effort for a child to recognize what it can see. An adult sees the form or shape of an object or word at a glance. The merest hint, and then association with past memories, places the word or object at once. Not so the child; details have to be pieced together to recognize and assimilate or apperceive the whole. For this reason well illuminated detail is educationally needed, especially the younger the child. It is as if a big voltage were wanted to carry the nervous impress over the resistances in the slightly developed nervous tracts of the child, otherwise the intellect is not reached, and recognition not attained.

Ordinary testing of school children's vision shows that in the first half of school life about one-third fail to attain the normal standards. A Board of Education Report shows that only one-third of the Blackburn children were recorded with normal vision. We have therefore to make a considerable allowance for subnormal vision whatever be its causes.

It is useful to remember that summer testing gives higher percentages normal than winter testing, presumably an indirect effect of illumination. The figures for Middlesex some years ago were 88 per cent. normal in summer, 78 in winter.

Ten per cent. of children leave the primary schools permanently shortsighted, and there are a few in the myope schools for whom special lighting regulations should be enacted.

There is still another point often overlooked and only likely to be gradually righted by long experience, unless now realized. In all bodily actions, whilst efforts can be made to work for a short time at full load, the normal working capacity falls far short of this.

In the eye itself we have a most excellent example of this physiological gospel that the body works best when well within the limits of its reserves, and that when reserves are called upon there is always risk of failure or breakdown.

Working Conditions.—The accommodation of the eye, that is, the alteration in the lens, brought about by contraction of the ciliary muscles, necessary to get clear images of objects at different distances, is a measurement which can be made within an error of a small fraction of one per cent. The muscular effort needed can be made, but it cannot be kept up to the full limit for more than a few seconds. The ordinary working capacity is only about a quarter of this, but can be kept up for long stretches of time.

Lighting tests by deciphering letters or numbers, or reading print, are likely to underestimate the optimum illumination by gross amounts.

The evidence is therefore against attempts to work continuously in school anywhere near the limits of visual efficiency, where our minimum lighting demand was placed.

If the minimum demand were doubled one would scarcely be wrong. The optimum now to recommend is just as much as is necessary or desirable. Experience shows that a child will not suffer obvious visual harm and ought to get proper educational advantage with amounts of illumination round about 5 to 7 foot-candles. Below this, whilst it can do its work, as a child it does it under an unfair load of effort.

The coming of the Half-watt Lamp.—Turning from the hygienic to the engineering aspects. The means of illumination are now enormously greater and relatively cheaper. The gasfilled (half-watt) lamp and the high-pressure and superheated low-pressure inverted gas burners have given sources which present completely different conditions to the carbon filament or the gas jets of the past. Improved forms of globes, bowls, and reflectors and fittings generally have been introduced.

These intense primary sources have to be diffused. The luminaire, to use the cumbrous but convenient American term, consists of a high-power source, which the eye cannot tolerate, and which has to be transformed by the luminaire to a tolerable secondary source. Instead of filaments or mantles of high intrinsic brilliance, a large evenly illuminated source of three or four hundred times less intensity is used to give a smooth, agreeable illumination. As in ventilation or in heating, comfort is a consideration only second to efficiency.

This represents a great advance which the illuminating engineer has developed elsewhere, and should fully develop in relation to the school.

The inverted gas mantle or the gasfilled lamp unshaded are dangers in school.

All naked sources should be shaded or screened. The intensity must be let down. The sky intensity averages $2\frac{1}{2}$ to 3 candles per square inch as projected, but primary sources now used run to hundreds or thousands of times this intrinsic brilliance, and if use is to be made of good lighting from these sources it must be through distribution by shades and reflectors. These are now a necessity for school purposes, and visible naked filaments or mantles, when in the direct range of vision, should now be required to be protected and shaded, in the official school regulations. A regulation should run: "No visible source of illumination should exceed three candles per square inch in intrinsic brilliancy."

Intrinsic Brightness.—The eye can endure the average brightness of the sky. It has been evolved through myriads of centuries to act best under this illumination, and this is about the standard of intrinsic brightness desirable for the luminaire: 3 candles per square inch. The use of higher brightness, as for instance 5 candles, may be permissible when luminaires are high up, out of the usual visual field, but the lower value must be insisted on for classroom purposes. Once the demand for large-surfaced inexpensive shades is established they will be produced.

Distribution.—The nature of the distribution—direct, semi-direct or indirect—has been much discussed. For school purposes the last may be left out. Mr. Sandeman some four years ago gave an interesting comparison of the cost of the three systems in cubic feet of gas per hour, per foot-candle, per square foot illuminated: direct 0·008, semi-direct 0·012, and indirect 0·016 (*The Illuminating Engineer*, January 1922). Most school doctors would at once say semi-indirect, but with the coming of the high power sources, and the provision of large globes or shades letting down the intensity to about 3 candles per square inch of luminaire surface, there is no hygienic preference of direct or semi-indirect worth discussion. The distribution becomes fairly even and glaring sources disappear.

An interesting report bearing on this is that prepared after considerable experiment by Mr. Henry Dates for his Education Board at Cleveland, Ohio, in 1922. He decided on a semi-indirect system, but the soft coal used locally produces so much dirt that the rapid depreciation by about 30 per cent. of the lighting and the poor reflection powers of wall surfaces necessitated adoption of direct lighting with totally enclosed units. He finally used 16-inch globes, described as Trojan or Monax 4386 ware, with 150-watt Mazda C clear lamps. The globes permitted the use of 200-watt lamps for special rooms such as sewing rooms. The surface brightness nowhere exceeded 3 candles per square inch. Six luminaires were used in a room of 28 x 32 feet at a

height of 8 ft. 10 in. The consumption worked out at one watt per square foot of surface and the average illumination a little over 5 foot-candles. The result of this was so satisfactory that Cleveland spent a quarter of a million dollars refitting its schools. This Cleveland report made me realize that the matter of upkeep is one for a trained staff, and not a schoolkeeper's job. If a large education authority is to get full value for its money and maintain efficiency in lighting it will have to appoint men for this special duty as illumination inspectors.

One of the points our Committee worked at specially and made a definite recommendation was that the blackboards needed accessory illumination of at least 60 per cent. over the rest of the room. This was illustrated later by a photograph in the Journal (May, 1915), but the American code suggests an illumination on the blackboard of only 60 per cent. of that allotted to desks, though it is specified elsewhere that special local illumination for blackboards may be advantageous.

Colour in Lighting.—The advantage of black on white, over grey on white or yellow on white, is very great below 4 foot-candles, but diminishes by 5 to 6 foot-candles, and remains stationary then.

We have to look ahead, and this question of relative colour of light will need consideration. Light filters have a considerable part to play in the future. Luckiesh suggested that blue tints should not be eliminated in decorations, and about the same time the question of colour came into enquiries. Foreign workers have got variable results with visual activity in different lights. Yellow light appears better than white, red a little worse, and blue the worst. With rapidity of reading, however, the blue and red change places, and the last paper on the subject concludes with a tentative recommendation that a high proportion of blue is recommended for rapid reading (*The Illuminating Engineer*, 1925, p. 300).

The comfort test of coloured light will not depend on special colours, but on relative proportions of colour in the light used. The chromatic aberration of the eye is only noticeable now and again. It gives us the illusion of receding or advancing colours as red or green on black. A flicker of alternate colours would probably give best information of the value of proportionate differences in colours making up illumination. The subject needs investigation.

My own troubles working with the reddish colour of ordinary lamps were not materially relieved by increasing illumination. With a 60-watt gasfilled blue daylight lamp 3 feet above my table and about a foot in front and to the left, I got more comfortable working. After a time this was increased to 100 watts, but the rapid deterioration from dust deposits, due to the heated air on the cooler shade above it, made me substitute a plain-bulb gasfilled 60-watt in an enamel reflector with its opening occluded by a daylight filter of Lamplough's Glass. This gives a very even illumination of about 7 foot-candles on the table, without any noticeable bluish tint, and does not seem to deteriorate from dust so readily. Since writing this I have discovered that there are several varieties, and that I am using what is called restlight glass. The chief thing is that one can work for hours without the slightest discomfort. This comfort means diminution of all kinds of trivial but cumulative strains on the eyes. These matters are very important in the myope schools. In America, where these schools have been enormously extended recently, they are stipulating for illumination of 15 foot-candles for artificial light. With the particularly sensitive eyes of these children it would be worth while substituting luminaires with large light filters of the material which I am using, and giving 7 to 10 foot-candles on their desks.

A Final Recommendation.—The American Code makes a list of detailed recommendations as to illumination. For classrooms it takes 5 to 10 foot-candles as desirable. Looking at the matter all round one is justified by experience since the former report in now suggesting an optimum artificial lighting for schoolrooms. It should be obtained by large luminaires of an intrinsic brightness up to 3 candles per square inch, giving an evenly diffused lighting of about 5 foot-candles on each desk. I recommend therefore 5 to 7 foot-candles as the desirable school provision for desk illumination, from visible sources not exceeding three candles per square inch.

Discussion

The CHAIRMAN (Dr. ELWIN H. NASH) paid a tribute to the very valuable work that Dr. Kerr had done in connection with school hygiene. He then called upon Mr. J. B. Lawford (Consulting Ophthalmic Surgeon at St. Thomas's Hospital and Moorfields Eye Hospital, and Past President of the Council of British Ophthalmologists) to open the discussion.

Mr. J. B. LAWFORD said that he was convinced that the question discussed in the paper was one of the most important that could come before the Society. The younger part of the population spent a great part of their time in schoolrooms, and whereas the developed eye had become more or less standardized the eye of the growing child required special care. Defects in lighting conditions were most liable to affect the tissues of the eyes of young people, which were elastic and not fully developed. He had been interested to observe the changes in views held on the subject of lighting in schools, since the report of the Joint Committee of the Society. The importance of adequate illumination in schools was much more fully recognized, and the ultra-violet rays in sunlight, about which comparatively little was known in 1914, were now believed to have a considerable influence on the development and growth of the tissues of the child, and especially on the tissues concerned in the organs of vision. He congratulated the author on his paper.

Mr. F. C. CLARKE, as a representative of the Association of Teachers in Technical Institutions, emphasized the special importance of good artificial lighting in evening schools. In elementary schools the children spent the greater part of their time working under daylight conditions. But in evening schools work was done mainly under artificial light, and thousands of young people came to study at such schools when their eyes were apt to be already tired after a day's work. In many cases the existing lighting in such schools left much to be desired. He laid stress on the necessity for adequate illumination of blackboards—as demonstrations on the blackboard commonly played an important part in instruction given in evening schools.

Mr. C. HUGHES contended that a great deal of the present school lighting was very unsatisfactory; in many cases children were expected to sit for hours at a stretch studying their books by an illumination far less than that available under daylight conditions and inadequate for the purpose. He fully agreed with what the author had said regarding the optimum. But he thought it was also desirable to establish a definite minimum, say 5 foot-candles, rather than to indicate a higher intensity without stating what the minimum should be.

He agreed that the curtailment of intrinsic brightness, with a view to diminishing glare was very important. But he thought that the absolute minimum of 3 candles per square inch might be somewhat increased. Much depended on the degree of contrast and the nature of surroundings. A fitting with the brightness of 3 candles per square inch might appear distinctly glaring when viewed against a dark background, yet a similar fitting having a greater brightness seen against a light background might not give any impression of glare. Importance should therefore be assigned to the nature of background, and walls and ceiling should be light in tint. Consideration should also be paid to the position of the source and the avoidance of any bright sources situated within the direct range of vision.

Following his remarks Mr. Hughes exhibited several fittings sent by Messrs. Siemens and English Electric Lamps Ltd., which were considered specially well adapted for school lighting. These included open white-glass reflectors, with lamps having the lower part of the bulb obscured, and completely enclosed diffusing units, the latter being specially recommended.

Mr. J. G. CLARK said he found himself in agreement with practically all the recommendations made by the

author. Dr. Kerr had very properly emphasized the drawbacks of unshaded lights, especially in schools attended by children. It surely required little imagination to realize the importance of the best available illumination in schools. The shading of sources, besides making them free from glare, had a material effect on efficiency. The use of reflectors with white inside surfaces helped very greatly in furnishing the necessary illumination at a minimum cost. It amazed him that even now this fact was often overlooked. The allowance of 3 candles per square inch for sources within the direct range of vision seemed to him a reasonable one.

Since the issue of the report of the Joint Committee of the Illuminating Engineering Society a considerable amount of useful work had been done in connection with the lighting of London schools, and he could say with confidence that there were new installations which complied completely with all the requirements laid down by Dr. Kerr. It was commonly said that school authorities were limited by considerations of economy, but it was necessary to bring home the view that good lighting was essential to the health and well-being of the rising generation. He thought that the Society could congratulate itself on the substantial improvement that had taken place in school lighting. That progress was no doubt due partly to the introduction of more efficient illuminants; but the illumination in schools in the past could have been much improved even with the lamps and appliances then available. The positions assigned to lights and the selection of suitable reflectors and shades had a great influence on the conditions of illumination provided. Maintenance was also a most important matter. He quite agreed with Dr. Kerr that this should be under skilled supervision. An installation should be so maintained that the illumination should never fall below 75 - 80 per cent of its initial value.

Improvements recently made in gas-lighted schools had not increased the consumption of gas. He thought it might be said that in the majority of cases, notwithstanding the better lighting, the consumption was less. The arrangement of desks in the standard classroom might well be considered in relation to the lighting. Generally desks were arranged in rows, and the back desks were apt to receive too little light. He fully agreed with what Dr. Kerr had said in regard to blackboard illumination. Consumers were still apt to think too much in terms of the candle-power of lamps provided. They should recognize that the important factor was the illumination on the desks, and that this depended mainly on the manner on which lights were shaded and arranged.

Mr. C. E. GREENSLADE (Borough Polytechnic) suggested that Dr. Kerr should omit the figure "5" in his recommendation on illumination and substitute definitely "not less than 7" foot-candles.

He believed that many people would acquiesce quite as readily in the higher value. In the evening schools, particularly, the illumination should not be less than 7 foot-candles. As Mr. Clarke had pointed out, students in evening schools commenced their study after a day's work, when their eyes were already becoming tired. To have the stumulus of the extra illumination of 7 foot-candles during the three hours' work was a distinct advantage.

In regard to blackboard-lighting much depended on the nature of the surface. He was under the impression that a slight tinge of blue was favourable to the observation of diagrams, especially if executed in coloured chalk. It should be remembered that blackboards were rarely quite clean, and were usually covered by a thin film of chalk which was apt to produce a species of veiling haze. He had formed the conclusion that with very high illuminations this haze was apt to be particularly noticeable.

Mr. S. T. SHORT (The Polytechnic, Regent St.) emphasized the important part played by the reflecting power of surfaces. The eye was mainly concerned with contrast and brightness. Thus on the blackboard it was the contrast between the white chalk and the dark background that rendered diagrams visible. If this contrast was small even a high illumination would not enable them to be easily seen. It was not quite clear from Dr. Kerr's paper which form of school was being considered. In elementary schools daylight was the more important; in evening schools, artificial lighting was mainly used. In the technical schools many different subjects were taught, and in some instances the nature of the instruction had some bearing on the method of lighting to be adopted. Hence it might be found necessary to make special recommendations for certain forms of work.

His personal inclination was strongly in favour of direct lighting, provided sources were placed high up, out of the direct range of view. With this system the efficiency was greatest, and this had a material influence on the cost—always an important consideration for educational bodies. He noticed that Dr. Kerr had implied that the eye could not work long at a full capacity. It would perhaps be more correct to say that it could not work for prolonged periods at any great overload. He congratulated the author on his paper.

Mr. JOHN DARCH expressed his satisfaction at the higher illumination now advocated by the author. Dr. Kerr had adopted the familiar conception of the brightness of the sky (about 3 candles per square inch) as the limit of brightness which the eye could survey with comfort. But he himself thought that glare was mainly a matter of contrast. It did not follow that because we could look with comfort at the wide expanse of sky we could look with equal comfort at a globe of similar brightness, viewed against a dark background. He was in favour of keeping all lighting units well out of the range of view, and he therefore preferred, when there was sufficient height available, overhead lighting from reflector fittings, of the type widely used in factories. He had lighted churches and classroom by this method and the results had given every satisfaction. The human eye could tolerate any amount of light coming from above, but one had to be very careful in allowing light to enter the eye from in front of it.

Mr. HARTLEY SHAW remarked that whilst standards of illumination were useful, it should not be overlooked that the direction from which light came was often important. This applied to many forms of close work in industry, and in technical colleges one had often to deal with processes resembling those in factories, and therefore needing special treatment.

The CHAIRMAN (Dr. ELWIN H. NASH) said that he was present at the meeting in three capacities. He happened to be the other medical member of the Joint Committee of the Illuminating Engineering Society over which Dr. Kerr had presided; he was also Chairman of the Medical Officers of Schools Association, and he was a member of the Ideal Classroom Committee formed by that body. Mr. Tye had referred to the system of lighting known as "left-hand balance." In a work published by him (Dr. Nash) in 1914 he had advocated this principle, and had experimentally lighted a school so as to produce the desired effect. By putting lights one foot away from the wall, he utilized the reflecting power of the wall to give the desired left-hand balance.

He agreed that in the majority of schools the great part of the lighting, for some time to come, would be direct lighting, chiefly because it was possible by this means to get the necessary illumination most economically. In regard to blackboard lighting an important consideration was the avoidance of troublesome glare in the form of direct reflection of sources of light from its more or less shiny surface. He had found that by tilting forward the top of the board several inches such reflections could usually be eliminated.

Dr. Nash also referred to several instances of the success of artificial sunlight in the treatment of various diseases, as illustrating how new knowledge was being acquired in regard to hitherto unsuspected influences of light.

In all lighting problems advisers of local authorities invariably found themselves "up against" the question of cost. Whilst illuminating engineers, and rightly so, were occupied in finding out the ideal methods of

lighting in practice, cost—both initial cost of installation and running expenses—influenced the view of educational authorities very strongly. As a rule maintenance had to be undertaken by the school caretaker, and this was one consideration in favour of direct lighting, as units did not suffer so much from accumulation of dust. In *The Illuminating Engineer* there had appeared from time to time beautiful examples of the lighting of shipping offices, banks and commercial offices, etc., but it must be remembered that in such cases the lighting was regarded from a business standpoint, as facilitating production and partly as an advertisement. In the case of educational bodies these considerations naturally did not apply in the same way, and also they had, as a rule, only very limited funds to expend.

Dr. JAMES KERR, replying briefly to some of the points raised in the discussion, said that the question of cost, though naturally one that had to be considered by authorities, should not be regarded as the predominant consideration. Certainly it should not prevent those interested in the subject from formulating ideal requirements. Good lighting was not necessarily expensive, and the expenditure should not be allowed to stand in the way of providing conditions essential to the vision and well-being of the children. Whilst, as various speakers had remarked, contrast played a part in determining "glare," he believed that the fundamental requirement was to eliminate all intense points of light, and it seemed to him judicious to avoid all exposure of the actual sources. From the hygienic standpoint the best lighting for educational purposes was that obtained from an extensive source of moderate brightness. The method of distributing and diffusing light was also of considerable importance in connection with the lighting of desk surfaces.

His aim in the paper had been to formulate several simple general principles, and the observance of these was compatible with considerable latitude in the precise methods of lighting adopted.

Mr. L. GASTER, in proposing a vote of thanks to Dr. Kerr for his paper, recalled the work of the Joint Committees of which he (Dr. Kerr) was Chairman. This was one of the earliest attempts to present general recommendations on school lighting, and, as Dr. Kerr had pointed out, most of them applied equally well to-day. In the United States various codes of school lighting had been adopted, including that framed by the Illuminating Engineering Society in that country. Whilst these contained somewhat more detailed recommendations on various points, there was general agreement in principle with the measures advocated here. Before the original recommendations were drawn up, visits were made to many typical schools, and several model installations were put up with the object of showing that the recommendations could readily be met in practice. Although, as Dr. Nash and others pointed out, educational bodies had often not much money to spend, it was clearly one of the very first things to be sure that the lighting was such as to enable work to be done with ease and comfort. In view of the improvements in illuminants and methods of lighting since the original report was issued, higher illumination should now prove practicable, as well as clearly desirable in the interests of vision.

Captain E. J. HALSTED HANBY, in a written communication received since the meeting, expressed his interest in Dr. Kerr's paper and his appreciation of the latter's favourable comment on the value of the Lamplough Restlight unit in relieving visual fatigue. A number of units of this type were on exhibit at the meeting. The absence of visual fatigue had been experienced by Mr. Lamplough in connection with the use of his true north light Daylamp for clerical work, drawing and designing, etc. But this unit naturally involved considerable absorption of light and was thus uneconomical for ordinary work, although of great value for processes in which accurate colour-matching was desirable. In addition the impression that this highly corrected light was "cold" was a drawback. These considerations led to the design of a modified "Restlight" screen, not intended primarily for colour work but generally resembling daylight in colour. The absorption of the light itself was almost exactly 50 per cent., but owing to the efficient use of the special reflectors and the efficient design of the bowl unit, its overall efficiency compared very favourably with ordinary types of bowl-units employing opal glass. Indeed in certain cases it had been found possible actually to diminish the current consumption by the introduction of Restlight units. In the Leeds Art Gallery there was a saving of 18 per cent. as compared with the original installation, consisting of bare lamps in opal reflectors; similarly at Marconi's (Radio House) an economy of 25 per cent. of the original consumption had been secured.

The Restlight units, although not so accurately "corrected" as the colour-matching Lamplough unit, nevertheless resembled daylight sufficiently closely to prove of value for art gallery and studio lighting; in art schools it had also the merit of eliminating the visual fatigue to which students of "black and white" were admittedly subject. Direct lighting from bare or insufficiently protected bulbs was quite prejudicial to good work; yet there were still a number of art schools lighted by these obsolete and ineffective methods.

The theory of the unit was based upon the facts that (a) the lack of achromatism in the human eye entails constant visual accommodation under "coloured" light, and (b) the well-known excess of orange-red, in ordinary illuminants, amounting to more than $4\frac{1}{2}$ times the corresponding value of daylight, in the spectrum of the electric light. The filter eliminated this excess and gave a soft white light, permitting visual accommodation similar to that enjoyed by daylight, for which the human eye is adapted. Dr. Kerr's interesting reference to Dr. Palgrave's tests in summer and winter supported this contention.

The Chairman and one or two other speakers had emphasized the necessity for economy, but he (Capt. Halsted Hanby) felt that the true view was that expressed by Mr. Hughes when he contended that economy at the expense of the eyesight of children is no economy at all. Millions each year are spent on education. The last budget shows a substantial increase on the previous one. But what purpose can be served by this expenditure if the conditions in schools are such that the children's eyes and brains are rendered incapable of assimilating the information afforded? When consideration is given to Dr. Kerr's valuable remark on the greater effort called for by the eyes of young children, and with the common experience of the somnolence and semi-hypnotic coma induced by a row of naked lamps in a lecture hall, the necessity for a form of lighting which eliminates these conditions, with probable economy in overhead cost, cannot be too strongly advocated.

Mr. L. M. TYE, Holophane Ltd. (*communicated*): I am pleased to add a few words to Dr. Kerr's most constructive paper, more particularly in view of the wide interest which is now generally being taken in the subject of School Lighting.

Whilst a good deal of discussion has to-night centred around the desirable standards of illumination for the classrooms, I do not think the question of the desirable number of points in a standard classroom to dimensions of approximately 23ft. by 22ft. has been touched. This I think is an important aspect, as in a careful review of plans received from a large number of boroughs in different parts of the country one is impressed by the wide diversity in their views on the subject. In some instances we find the authorities stipulating for as few as three points to a classroom, in others as high as eight.

Now, with the need for financial economy, as several speakers have emphasized, it would seem to be a very helpful piece of work if the Society could issue some general recommendation as to the desirable spacings to be adopted, taking into due regard the need for efficiency, uniformity of illumination and elimination of troublesome shadows.

In regard to efficiency, classroom lighting has always appealed to the speaker as being essentially a case of localized general lighting where the working surface, the desk, is the essential; at the same time adequate lighting of vertical surfaces should be provided, e.g., for

the blackboard and for diagrams on walls. This clearly emphasizes the importance of correct light-distribution, which was the basic principle of many of the earlier and highly successful installations carried out employing Holophane Stiletto Reflectors. In later examples, where Holophane Reflector refractor units have been employed with gasfilled lamps, distribution of light is likewise carefully considered.

This question is really a vital one and materially affects upkeep cost.

A further point which I should like to see discussed is the practical advantages of outspacing the lighting points a foot or more to the left of scholars, so that artificial light should conform more nearly to the direction of daylight and thus further minimize the effect of shadow.

Mr. DOUGLAS DIXON, in a written communication, remarked that the illuminating engineer is in some ways favourably placed in dealing with school-lighting, as so much is done under the Ministry of Education, and there is some unification of control. Nevertheless, in his own experience among public and elementary schools, barriers to improvement, both psychological and financial, are difficult to overcome. Buildings are usually old, and classrooms frequently lack uniformity. Not infrequently the economist becomes busy replacing white bulb lamps by clear ones of half the wattage; yet lamps of twice the original wattage may ultimately be substituted!

Six foot-candles appears to be adequate for nearly all purposes, and we have probably as yet insufficient data to justify very much higher illuminations when expense is of moment. The quality of paper used for school books deserves attention. Highly-glazed surfaces are doubtless conducive to eyestrain. Totally enclosed units, though somewhat expensive, appear most satisfactory; unshielded lamps should invariably be "white" or at least frosted. The method of internal frosting recently mentioned in *The Illuminating Engineer* is of special interest, as the cleaning of lamps and fittings is an important consideration, often neglected.

Naturally other problems than those involved in lighting classrooms arise. For gymnasia and drill halls "Glasteel" diffusers can hardly be bettered, but there is a wide range of lighting units available. An enclosed unit with a concentrating reflector let into the base of the glassware, recently developed for hospital lighting, appears well adapted for lighting dormitories. Blackboards often present somewhat awkward problems, and the possibilities of the "Pointolite" and other lamps for use with lanterns deserve to be more widely known. Another point of considerable importance in the lighting of school buildings is *safety*, and for this reason a sufficiency of pilot lights or lamps under separate control is desirable; in the larger schools, especially in rural districts, private generation is often worth consideration, partly as an educational factor in connection with the engineering side.

There is ample room for energetic propaganda on school lighting by this Society and others interested in promoting public appreciation of the benefits of good illumination.

Board of Trade Announcement

COMMITTEE ON DATING AND SEALING PATENTS.

The Board of Trade have appointed a Committee, consisting of Mr. J. Whitehead, K.C. (Chairman), Mr. H. A. Gill, M.A., Mr. A. J. Martin, O.B.E., Major-General Sir Philip Nash, K.C.M.G., C.B., and Mr. J. Swinburne, M.Inst.C.E., F.R.S., to inquire into and report whether any, and if so what, change is desirable in the practice of the United Kingdom of

(*a*) Dating and sealing patents applied for under Section 91 of the Patents Acts, 1907 and 1919, as of the date of the application in the foreign State;

(*b*) Dating and sealing other patents as of the date of application, as provided by Section 13 of the Acts.

The Secretary to the Committee is Mr. B. G. Crewe, The Patent Office, 25, Southampton Buildings, London, W.C.2, to whom all communications relating to the work of the Committee should be addressed.

The Atom of Light and the Atom of Electricity

A SERIES of lectures dealing with the above fascinating subjects was recently given by Dr. C. D. Ellis at the Royal Institution.

In the first lecture, in contrasting the two possible theories of light (the spreading-wave theory and the light quantum theory) Dr. Ellis pointed out that both theories were completely successful in explaining certain groups of phenomena, but neither is competent to explain all the phenomena. However, without committing oneself completely to the light quantum theory, there is yet a great advantage in adopting it as a provisional hypothesis, because of the simple explanation it gives to the photo-electric effect. The photo-electric effect consists of the emission of electrons under the action of radiation, and the important phenomenon is that the number of electrons ejected depends only upon the intensity, but that the velocity of the electrons depends only upon the frequency. It is this fact that is inexplicable on the spreading-wave theory, but which receives a simple explanation on the light quantum theory.

In the second lecture Dr. Ellis described the experiments by which the second relation has been verified and to show how the velocity of the electrons depends upon frequency of radiation. It was pointed out that the correct picture was that the quantum of light on being absorbed gave its complete energy to the electron. This energy was given to the electron when the latter was bound to the atom. Before the electron could get free from the atom a certain amount of this energy was used up in moving the electron away from the positive attraction of the nucleus. This process was illustrated by reference to various models of atoms.

The method of measuring the velocity of the electron ejected by X-rays is to bend them by means of a magnetic field, and some experiments were shown to illustrate this bending. The type of apparatus used was next demonstrated and a typical experiment described by means of a large scale model. It is found that one particular frequency of radiation ejects several groups of electrons of different speeds from any one particular *type* of atom. This is just what would be expected on this theory coupled with the modern view of the atom.

On this view the electrons in the atom are arranged in a series of definite shells. The electrons nearest the nucleus will require most energy to free them from the atom, and will therefore belong to the group with the smallest final energy. Hence to each shell of electrons there corresponds a definite group of ejected photo-electrons. This method is of great importance in investigating the inner structure of the atom. To illustrate these facts a film was shown. On this film two spots of light rotated about a stationary fixed point, and were intended to illustrate two electrons rotating about the nucleus. A process of absorption of energy was shown by the advance of a light quantum on to the atom and the change in motion of the electrons.

Two examples were given, that of the excitation of resonance radiation and of the photo-electric effect. In the resonance radiation (of which experiments were also shown) the electron moves from its normal orbit into a more distant orbit, but remains still bound to the atom. Subsequently it returns, and it emits precisely the same radiation that it absorbed. In the photo-electric effect the electron is ejected clear of the atom. The atom is now left in an ionised state, and the other electron makes a transition to the now vacant inner ring and emits a quantum of lower frequency radiation, this radiation being, in this case, characteristic of the atom. It was pointed out how this last process has been proved to exist, and the experiments of the measurement of the special rays resulting as a secondary process of the absorption of the rays in the radio-active atoms were described.

Recommendations on School Lighting*

IN view of the suggestions made in the paper on school lighting read by Dr. James Kerr at the meeting of the Illuminating Engineering Society on April 29th, the following recommendations contained in the Report presented by Mr. L. B. Marks at the meeting of the International Illumination Commission in 1924 are of interest: —

(1) *Illumination Required.*—The illumination shall not be less than given in the following table: —

	Minimum Ft.-candles.
On the space† : —	
Walks, drives, and other outdoor areas, if used at night	0·1
Playgrounds, outdoor, if used at night	0·5
Playgrounds, outdoor, if used at night for games...	5
Storage spaces, passages not used by pupils ...	0·25
Boiler rooms, power plants, and similar auxiliary spaces	1
Stairways, landings, corridors, aisles, exits, elevator cars, washrooms, toilets, etc.	1
Recreation rooms, gymnasia, swimming pools	3
On the work† : —	
Auditoriums, assembly rooms ...	2
Auditoriums, assembly rooms, if used for class or study purposes ...	5
Classrooms, study rooms (desk tops) ...	5
Classrooms, study rooms (charts, blackboards)	3
Libraries (reading tables, catalogues) ...	5
Libraries (bookshelves, vertical plane) ...	3
Laboratories (tables, apparatus)	5
Manual training rooms, workshops, etc.	5
Drafting rooms, sewing ...	8

(2) *Avoidance of Glare, Diffusion and Distribution of Light.*—Lighting, whether natural or artificial, shall be such as to avoid glare, objectionable shadows and extreme contrasts, and to provide a good distribution of light; in artificial lighting systems lamps shall be so installed in regard to height, location, spacing, and reflectors, shades, or other suitable accessories, as to accomplish these objects.

Bare light sources, such as exposed lamp filaments or gas mantles, located within the ordinary field of the worker's vision, are presumptive evidence of glare.

For a specification of definite requirements under this rule reference should be made to accompanying "glare tables," such as those given in the American Standard Code.

In a classroom at the desk tops the ratio of the maximum intensity of artificial illumination to the minimum intensity of artificial illumination, measured in foot-candles, shall be less than four.

(3) *Colour and Finish of Interior.*—In rooms in which close visual application is necessary walls shall have a reflection factor within the range of 30 to 50 per cent. Ceilings and friezes (the latter in the case of high ceilings) shall have a reflection factor of at least 65 per cent. Desk tops and other woodwork shall have a reflection factor not exceeding 25 per cent. In corridors and halls, ceilings and walls shall have a reflection factor of at least 50 per cent. Dadoes and blackboards are obvious exceptions. Glossy finishes shall be avoided wherever they are likely to cause glare. The preferred colours for walls are light warm grey, light buff, dark cream and greyish green; for ceilings and friezes, white and light cream.

The nosing of treads on all stairs used as exits shall be such as to show the edge of each step by contrast when viewed as in descending.

(4) *Exit and Emergency Lighting.*—The lighting to be provided under Section (1) in all stairways and exits of factories and in the passageways appurtenant thereto shall be supplied so as not to be subject to failure because of the failure of a room or work space lighting from internal causes, and shall be supplied preferably from an independent connection extending back to the main service entrance of the building. In case of unusual danger which may exist on account of type of building, nature of the work, crowded conditions or lack of suitable exit space, an independent service shall be ensured by connecting to a separate source of supply without or within the building.

Classrooms and auditoriums during stereopticon and motion-picture exhibitions may be dimmed. After dark, if more than 50 persons are gathered in rooms having an illumination of less than 0·1 foot-candle, the exits from rooms and all passages to the exits of the building shall be indicated by adequately illuminated exit signs, so as to clearly indicate the paths of safe exit from the building in case of emergency.

(5) *Inspection and Maintenance.*—All parts of the natural and artificial lighting systems, including windows, skylights, lamps, luminaires, walls and ceilings, shall be systematically inspected and properly maintained and cleaned so as to assure illumination levels indicated in Section (1).

(6) *Blackboards.*—Blackboards shall be illuminated and located with respect to light sources so as to avoid glare. The surface of blackboards shall be made and kept as dull as possible. Blackboards shall not be located in the same wall with windows.

* Based on the Report presented by Mr. L. B. Marks, Chairman of the Committee on Factory and School Lighting, at the meeting of the International Illumination Commission at Geneva, in July, 1924.

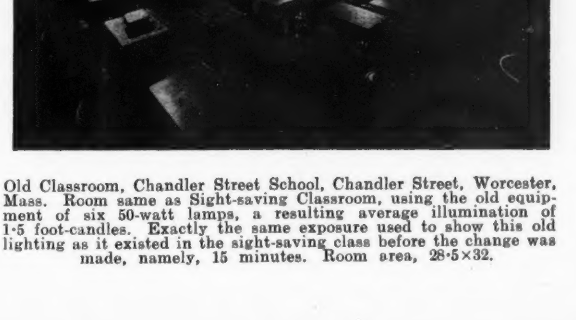
† Where the space or work is not clearly evident, as, for instance, in an auditorium, the illumination may be measured on a horizontal plane 30 inches above the floor. However, where the space or work is clearly evident, such as stair steps and desk tops, the illumination shall be measured on the plane of the steps and desk tops respectively.

Improved Classroom Lighting at Worcester, Massachusetts, U.S.A.

FROM Dr. James Kerr we have received some particulars of improvements recently carried out in school lighting at Worcester, Mass., U.S.A.

Like many other cities, Worcester schools are overcrowded. Since September, 1923, the sight-saving classes have been on double session in the Chandler Street School. This is one of the oldest buildings of the city and the rooms on the first floor do not have an abundance of sunlight.

The second division, or grades one to five inclusive, comes at twelve and stays until four. During the winter months artificial lights must be used from three to four o'clock on pleasant days, and for the entire session on stormy days. But, as will be seen from the following report made by Wesley S. Mowry, Illumination Specialist



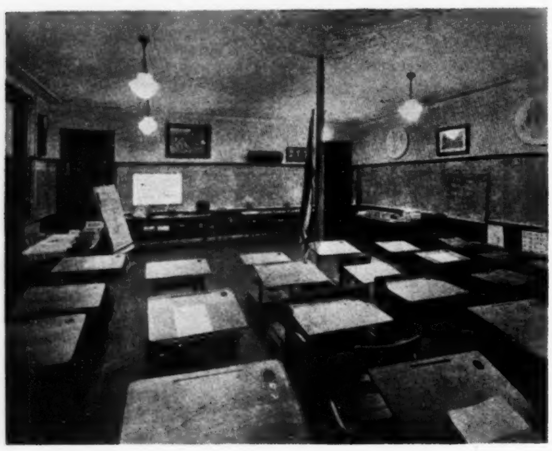
Old Classroom, Chandler Street School, Chandler Street, Worcester, Mass. Room same as Sight-saving Classroom, using the old equipment of six 50-watt lamps, a resulting average illumination of 1·5 foot-candles. Exactly the same exposure used to show this old lighting as it existed in the sight-saving class before the change was made, namely, 15 minutes. Room area, 28·5×32.

of the Worcester Electric Light Company, the system in use up to February, 1924, was worse than no light at all:—

"A sight-saving classroom for children with very low vision and various eye defects was found with an illumination of from one to four foot-candles, the majority of the area being from one to two foot-candles. The lighting equipment consisted of six 50-watt type B lamps and an open-bottom direct-lighting reflector. It was desired to remedy such a lighting condition, poor indeed for the average eye, but terrible to contemplate for children many of whom cannot even be fitted to glasses.

"In lighting a schoolroom for children with defective eyesight the requirements of the ordinary schoolroom become doubly important. The equipment should be chosen with the result in mind of giving the best possible illumination, not just approximating it.

"With this in mind, the following are some of the conditions to be met by such a lighting unit. The brightness of the unit itself, or the light emitted per square inch, should be low at the angles through which the unit is seen. The unit also should not be spotty. (In the case of white-glass direct-lighting units this would mean in the ordinary schoolroom the choosing of an oversized globe for a given size of lamp, thus decreasing the brightness.)"



Photograph of Sight-saving Classroom, Chandler Street School, Worcester, Mass. Photograph unretouched and showing the improved lighting with exactly the same time exposure as given to the comparison picture of old lighting as typified in another room. Resulting foot-candles averaged between cleaning periods, 10. Watts per each, 300 clear type. Room area, 28·5×32. Number of lights, 6.

In the accompanying two photographs the contrast between the original lighting conditions and those now provided is clearly shown. The illumination has been raised from 1·5 to 10 foot-candles and the lamps have been screened by totally enclosed units of the diffusing type.

Light, Sight and Safety*

By R. E. SIMPSON (Travellers' Insurance Company)

ACCIDENTS do not simply happen more or less haphazardly, but are caused—there is an underlying reason back of every accident. Often there are many factors not apparent at the time and place of an accident that have some bearing on the cause, and nowhere is this so true as in the matter of ability to see. There is indisputable evidence that the momentary and temporary blindness caused by workmen having unshaded lamps close to their eyes and in the direct line of their vision is directly responsible for many industrial accidents. There is also evidence of accidents because of this same kind of blindness due to the specular reflection—more commonly known as glare—from brightly polished material within the range of vision. These and many other evils of illumination prevalent a decade ago were reflected in the accident rate to the extent of being decidedly contributing factors in *one out of every four accidents.*

During the intervening years there has been a decided improvement in the working conditions in our industrial plants. First the idea that it is much cheaper and more humane to prevent accidents than to pay damage claims is now generally recognized. The principal outward manifestation of this idea is the general toning up of the physical condition of shops and factories. Exposed gears, belts, set screws, shaft ends, revolving wheels and similar accident-producing agencies are quite generally guarded. In like manner band saws, circular saws, punch presses, etc., are equipped with guards of such design that injury is possible only by deliberately removing the guard. There is a much better grade of good housekeeping in that stairways and elevated platforms are kept in a state of good repair and provided with guard rails and toe boards while passageways and aisles are quite generally kept free from obstruction. Shop safety organizations have been created and thorough study made of safe methods and practices in carrying on industry, and workmen have been taught by example and precept to exercise care. Accompanying all this there has been a gradual improvement in the illumination both as to higher intensity levels and proper use of lighting equipment, thus correcting faults of distribution and glare.

The effect of these improvements has been that accidents have been materially reduced. Yet it is estimated that improper illumination and defective vision are to-day the major factors in one out of every eight accidents.

In the second part of his address Mr. Simpson turned to the requirements of the growing child. Even those parents who realize the importance of proper lighting conditions have to meet the fact that children are naturally careless in this respect. In the author's own home, "in spite of warnings, corrections and scoldings, one or more of the four daughters will make unusual demands on her eyes . . . a favourite performance of the younger element is to spread the evening paper on the floor, usually in a corner to avoid being stepped on by others, and thus at leisure absorb the wisdom and complete their higher education from the so-called comic section. . . . . They will read while facing a window with bright-sky exposure, assume positions best calculated to produce glare and strain from artificial lights, and will read or play games in the poor light of dusk rather than bother themselves to the extent of turning on the lights. . . ." It seems reasonable to conclude that there is a general lack of supervision by parents of the strain children place on their eyes; and this, supplemented by inadequate illumination in the home, inevitably brings about defects of vision.

Moreover, Mr. Simpson remarks, we have not yet reached the stage where we may point with pride to the lighting of our public schools. Many, especially those recently built, are well lighted, but the majority are not. Insufficient illumination and glare from desk tops and blackboard are the most common faults. Fairly comprehensive investigations have shown that fully 60 per cent. of children in schools have defective vision—either inherited or brought about by misuse of the eyes before the children enter school. Unsatisfactory lighting conditions in schools tend to accentuate these initial defects. Hence we find a material increase in the number of children with imperfect vision at the end of the high-school period, as compared with the commencement.

Meantime industry must go on, and there is a constant demand for new workers to take the place of the aged and infirm. The supply is drawn largely from elementary schools. Hence it is found that many of the new workers start out handicapped with respect to vision. Here again both the number afflicted and the degree of the affliction increase with age, so that to-day fully 66 per cent. of workers have defects of vision.

In many cases it is response or failure to respond to visual impressions that determines whether safety or injury results. If indistinct vision causes a delay of even a fraction of a second in recognizing a point of

* Abstract of an address delivered before the Eyesight Conservation Council of America.

danger an accident may occur. This is doubtless the explanation of many accidents where the injured person truthfully says that he did not see the danger point.

Mr. Simpson mentions two cases within his personal observations that illustrate this fact. A boy, 16 years old, had failed to pass his second year high-school work, and the family circumstances were such that it was thought best to start work rather than to make up the school-work deficiency in summer or repeat the school year. Shortly after starting in a shop having the best of modern illumination, he was stationed at an automatic machine. Within a few days another machine in the same aisle had to be repaired, and the machinist, in order to do the required work, removed the rear guard and placed it on the floor near by. At about this time the high-school boy left his machine and stumbled over the guard. The machinist meanwhile had risen to start the machine to test his work. The boy's hand was caught in the gears as he fell, and all four fingers were mangled. The guard was plainly visible to one of normal eyesight, but, as was discovered later, the boy was moderately near-sighted, and so failed to see the obstruction. Somewhere, some one or more persons responsible for the training and well-being of this boy failed of their duty. A pair of glasses at the cost of a few dollars might have made possible a complete high-school course, or would presumably have prevented the accident. Instead, we have a boy who before he had attained his seventeenth birthday was thrust out into the world to make his own way, doubly handicapped by defective vision and a crippled hand.

The other incident, which had a more happy ending, has to do with a boy also sixteen years old, but so backward in his studies that he barely finished the eighth grade school work. He also accepted employment in a well-lighted shop, and within a week had twice narrowly escaped injury and was responsible for much damaged material and poor work. His foreman, instead of discharging him or reprimanding him, asked some questions and made a rather elementary eye test, which led to a visit to a refractionist, where correcting lenses were supplied for the serious visual defect from which the boy was suffering. Encouraged by his foreman, he attended the night sessions of a technical trade school and progressed so rapidly that within four years he was assistant superintendent of the shop.

There was poor lighting in the homes of both of these boys and poor lighting in the schools. Thus the parents and school authorities had laboured with these boys without discovering the fundamental cause of their backwardness, and the only result of their labours was to turn both boys over to industry seriously handicapped both mentally and physically. Boys and girls taken from school in this condition are in the same position as the so-called "seconds" or inferior goods turned out by our manufacturers. Neither can command top prices, but must be satisfied with a secondary rating. The seconds of commerce are disposed of at reduced prices, while the seconds from our schools go on handicapped by great likelihood of injury, low productive capacity and greatly curtailed opportunities for winning advancement and many of the comforts of life.

To bring about an improvement there is available only a small number of workers for good illumination and eyesight conservation compared with the magnitude of the task. For, first of all, our homes must be better lighted, and this should be supplemented with intelligent and thorough supervision and care of the children's eyes. The illumination in our schools must be brought up to date, and annual eye examinations of all children must be a permanent policy. By this latter policy eye defects are likely to be discovered early, and with proper care the trouble may be arrested. Parents, teachers, and school boards must be made to realize their responsibilities, that they are guardians of the coming generation, and that the means to assist them in their guardianship are theirs not by *asking*, but by simply *accepting* that which is offered them by experts. There is immense inertia to be overcome and a vast amount of work to be done, principally of an educational kind, before much progress will be noted. Until this is done, we may be sure that many puzzling accidents could be explained if we could peep back into the injured person's life and ascertain the kind of "illumination" and eye care he had between the cradle and the time he started to work.

Some Problems in the Lighting of Technical Schools and Colleges

WHEN the question of "school lighting" is raised most people think at once of the lighting of elementary schools. Seeing that there are said to be over a million children in the elementary schools of London alone, the importance of this form of lighting cannot be minimized. It is of vital importance that the artificial lighting, as well as the natural lighting, should be adequate. Yet—perhaps fortunately—elementary school children in this country do not as a rule work much under artificial light; in the summer, particularly, the work is done almost exclusively by daylight. In other lands, for instance in Finland, the sun does not rise above the horizon for long periods during the winter. Hence artificial light has to be applied continuously at such times. But in the British Isles natural lighting is mainly used.

In many other forms of schools, on the other hand, secondary schools, the large public schools and grammar schools, and trade and technical schools and colleges, the proportion of work done under artificial light is much greater. Especially is this true of polytechnics, and technical schools and colleges, where evening classes often form an important feature of the regular work. In such cases artificial lighting is used to a great extent. Not only this, but the variety of uses to which it is put is much greater. Some technical schools and colleges may be likened to miniature factories or workshops. They have the usual lecture halls and classrooms, but they have also laboratories, work-

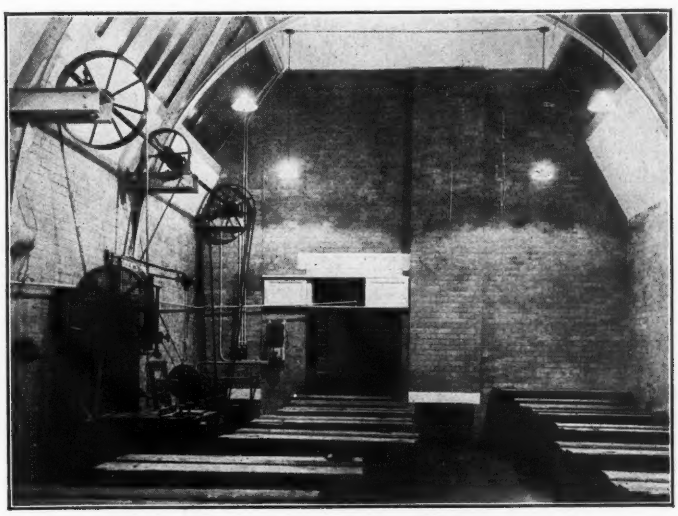


Fig. 1.—Woodwork Shop (Newport Technical Institute).

shops and art rooms, all of which introduce special lighting problems. In these cases it is not merely the printed page that has to be illuminated; the lighting of the objects examined and handled is perhaps even more vital. In some of the trade schools—for example, those devoted to sewing and arts and crafts—the lighting requirements are very exacting. The processes are almost as fatiguing as those undertaken in factories, and it is to be remembered that many of the pupils are relatively young, and thus in a condition when inadequate lighting is liable to produce fatigue.

In order to illustrate some of these varying aspects of lighting we are reproducing one or two illustrations that appeared in a recent issue of *Holophane Illumination* devoted to school lighting. The variety of lighting units adopted, stiletto reflectors, reflector bowls, etc., is worth noting. It is very useful to have certain units adapted for application in certain classes of rooms, but the skill with which the lighting units are arranged is equally important.

The four illustrations selected show the lighting of a woodwork shop, an engineering laboratory, a chemical laboratory, and an art room at Newport Technical Institute. All are reproduced from photographs taken by artificial light, and give a good impression of bright general lighting. One may say with confidence that in rooms of this character the illumination should not be less than 5 foot-candles. Naturally, avoidance of glare must be studied, and in these cases the sources are shaded and placed well up out of the direct range of vision.

These rooms present their individual problems. In the woodwork room the avoidance of troublesome shadows is perhaps one of the main factors. We have here to deal with individual work with hand tools. In using a plane, saw or chisel, an awkward shadow may at once be responsible for spoiled work—especially in the case of young students who are still novices in the work. Light surroundings are of great benefit. Fortunately, experience suggests that in woodwork shops operators are generally assisted by light colour of the material; with dark woods, oak, teak, mahogany, etc., a higher illumination is wanted than for white deal.

In the art room shadow conditions are again vital. An art student is dependent entirely on the impressions of the eye, and there should surely be no need to emphasize the need for careful lighting. There is room for further investigations of the best methods of lighting such rooms. When painting by night is undertaken—as in many of the art schools in London—surely the very first consideration should be to install a system of "artificial daylight." In chemical laboratories, also, many processes are judged by delicate colour changes in indicators (e.g., methyl orange, phenol-phthalein, etc.), so that here, too, a few portable lamps designed for colour matching are helpful. Generally speaking, in all such rooms ample connections for special local lighting units should be provided. However perfect the general lighting, one can never foresee when local illumination for some special purpose may be required.

Fig. 2.—Lighting of the Engineering Laboratory.

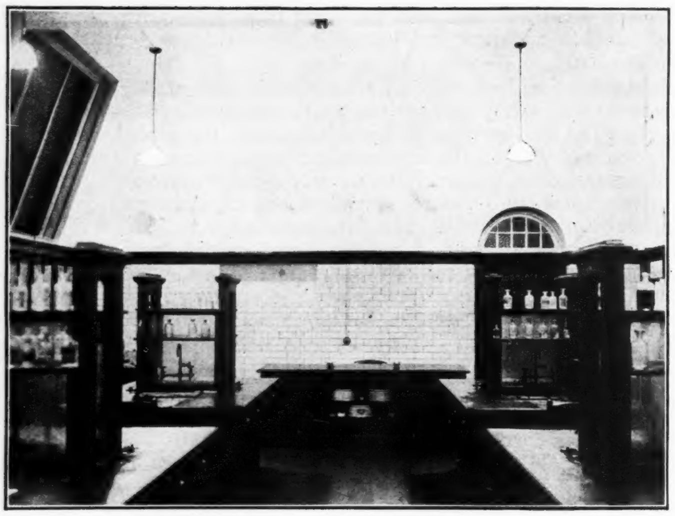


Fig. 3.—Lighting of the Chemical Laboratory.

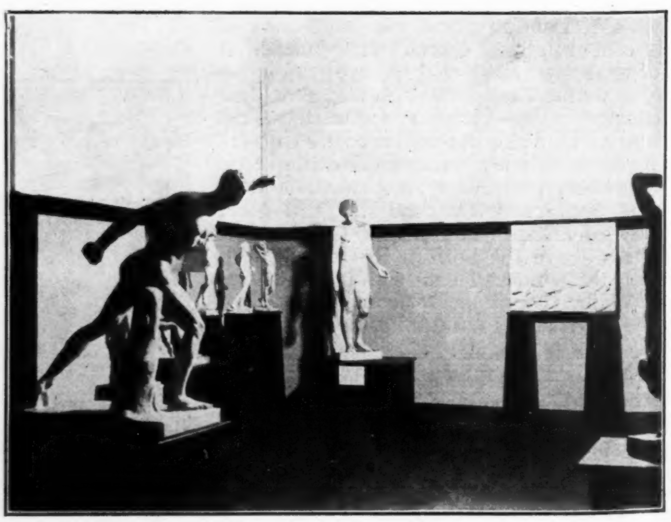


Fig. 4.—Lighting of the Art Room.

Photographs illustrating Artificial Lighting of various Rooms at Newport Technical Institute.

Modern Methods of Gas Lighting in Schools

THE necessity for good lighting in schools, in the interests of health and vision of children, is being continually emphasized. The usual difficulty raised by school managers and others is that of cost. They may admit the need for improvement in the existing lighting. But they profess doubt as to where the money can be found to pay for the higher illumination.

In such cases it is well to realize that the substitution of better lighting does not always mean corresponding expense. In many cases, owing to the fact that obsolete lamps, burners and fittings are in use, much better lighting conditions can be obtained at a relatively small initial cost, and with little if any increase in the running costs of the lighting system. This has been the experience in many gas-lighted schools where the obsolete upright gas burners and shades were in use.

The classroom shown in the illustration was originally lighted by "C" upright burners. For these, three-light superheated cluster burners with No. 2 size mantles and 10-in. by 5-in. conical shades have been substituted. The deep shade was adopted in order to ensure absence of glare in the eyes of teachers and pupils. The burners are made of heavy brass and cast aluminium in order to give long and satisfactory service. This classroom is 26 feet long and 25 feet 6 inches broad, and is thus typical of usual dimensions. The lighting conditions are considered to have been very much improved.

In all such cases the conversion to superheated inverted burners is easily and simply effected. In general, such fittings give about 50 per cent. more light, for the same consumption of gas, as the obsolete upright type, and they have the advantage that the cost of maintenance is also less owing to the more robust nature of the inverted mantles.

FIG. 1.—Showing Gas Lighting of a Modern Classroom by 3-light Superheated cluster burners.

The Work of the Carnegie United Kingdom Trust

THE twelfth annual report of the executive committee of the Carnegie United Kingdom Trust for the past year, makes interesting reading. It may be recalled that the Trust was originated in 1913. The subsequent two years were expended mainly in preliminary work. There have since been two periods of five years' steady development, of which the second has just terminated.

The primary object of the Trust, as originally conceived, was the encouragement of libraries, but as foreseen this has brought with it many supplementary activities. It is remarked in the report that the original line of policy has been amply justified and has been closely adhered to, but to those unfamiliar with its work it will come as a revelation to find how many and varied are the problems with which the Trust is now concerned.

From the accounts for the past year it appears that the total payments made amounted to £155,742 12s. 3d. Of this sum £90,966 was allotted to libraries and the remainder to various supplementary objects (rural development, music and related activities, physical welfare, hostels, etc.). All these activities may be explained by the broad view that study, to be effective, must be aided by health and by suitable opportunities for recreation.

In connection with libraries we are glad to observe the attention being devoted to "planning," including the provision of adequate heating and ventilation. An example of this branch of activities is to be found in the design of a model newspaper room. Considerable attention is being paid to the encouragement of Central Libraries for Students; and, as we have previously mentioned, the Trust has given generous assistance to work of the Association of Special Libraries and Information Bureaux in preparing a directory of all such libraries, which should be invaluable to the student. The Association of University Teachers is endeavouring to establish a central bureau for the exchange of information. As another instance of the widespread activities of the Trust we may mention the arrangements being made for the supply of books to lighthouses and lightships, certainly a deserving object.

The past year has, however, been marked by progress in new directions. There are two well-marked lines of development, the promotion of physical welfare and the encouragement of intellectual and artistic recreation. In the field of physical welfare we note the establishment of model infant and child welfare centres in numerous areas, and the establishment of hostels for young people. Aid has also been given to the investigations of the National Institute of Industrial Psychology, whose work in connection with vocational selection has been attracting a considerable amount of attention. In the second division we may place the enterprising efforts to encourage music and the drama, and the establishment of village clubs which become centres of study and recreation. Of these the "rural college" at Sawston is an interesting experiment. A noteworthy step in connection with drama has been the purchase of Sadlers Wells Theatre, which it is hoped will perform educational functions similar to those being exercised by "The Old Vic." Organized village concerts are being undertaken by a band of enthusiasts, and local dramatic performances arranged by the Arts League. The Trust is doubtless upon sure ground in suggesting that such performances must somehow pay their way. Naturally at the commencement some support may be necessary, but ultimately they should command

sufficient support. Other useful steps include the formation of an orchestral loan library and the publication of various orchestral works which would otherwise be difficult to obtain.

In all these varied efforts the Trust acts in co-operation with local bodies, granting financial assistance but using the services of enthusiasts in these various fields. In what is sometimes considered to be a "commercial age" it is refreshing to find that there are still so many people willing to expend effort in a good cause for the love of it.

The developments in the activities of the Trust will doubtless meet with general approval. In dealing with libraries, for example, it is clearly impracticable to stop short at the provision of books. Facilities for making use of them must also be considered. One would like the Trust to give some thought to the question of the lighting of libraries. Good illumination is necessary in order that books may be read with pleasure and profit, and in order to safeguard the vision and health of readers, many of them young people whose eyes are liable to be affected by bad lighting conditions.

Similarly we would like to urge that the Trust's beneficent work in the interests of physical welfare should include the applications of light in the interest of health and safety. This, we conceive, is just the kind of work which, in the near future, should come within the scope of the Carnegie Trust. It is being recognized more and more clearly how close is the relation between light and health. In the daily life of all, young and old, in the home and in the hostel and schoolroom, the provision of adequate illumination is a primary necessity. As a result of the investigations of the Illuminating Engineering Society the general principles of lighting in the home and in the school are now well established, and such details as remain to be worked out are being effectively studied, for example, by the Committee on the Ideal Classroom formed by the Medical Officers of Schools Association, on which the Illuminating Engineering Society is represented. What is necessary is that all this available information should be brought to the notice of those interested, not only members of the public but teachers, medical officers and education authorities. Propaganda and educational efforts in this direction will doubtless be regarded sympathetically by the Carnegie Trust, as fulfilling the aims for which it was created.

The Theory of the Ulbricht Sphere

A paper recently read by Dr. H. Hartinger before the Illuminating Engineering Society in Germany on the theory of the Ulbricht Sphere (or the "Integrating Photometer," as it is known in this country) led to a discussion on several sources of possible error in the apparatus. Dr. Dziobek drew attention to the selective reflection of the inner coating of the sphere, and of the diffusing glass window commonly used, both of which tend to make the derived light somewhat "redder." Recent tests at the Reichsanstalt have shown that errors of $3\frac{1}{2}$ to 4 per cent. may thus be introduced. A somewhat unexpected conclusion was that the diffusing glass window is responsible for the greater part of the error; its effect was to reduce the apparent "colour temperature" of a lamp by 115°, whereas the fall occasioned by selective reflection of the inner coating of the sphere was only 25°. The use of the diffusing window glass is not really necessary and can be avoided by various expedients.

Dr. M. Pirani also discussed this source of error and described a method of calibrating the sphere for several colour-temperatures. He also referred to the fact that sources with unsymmetrical distribution of light, for example lamps with the bulb half silvered, give distinctly different results according to their position in the sphere. Even in the case of lamps with the inside of the bulb half-frosted slight differences of $1-1.5$ per cent. may be noted. Apparently these errors are due to departure of the inner surface from the cosine law. Further information is also desired on the degree of error introduced by the fact that lamps or lighting units tested may have an appreciable size and thus obstruct the free diffusion of light.

Lighting Developments in the City of Glasgow

An informative report of work carried out by the Lighting Department of the City of Glasgow during the past year has been presented by the Inspector of Lighting (Mr. S. B. Langlands). The lighting of the City of Glasgow, with its extensions, presents special problems. The mileage of streets exceeds 500, and for the lighting of streets and stairs over 6,000,000 candle-power is now provided. It is to be noted that the lighting of "stairs" figures largely in the Glasgow reports. These stairs utilize as many as 80,000 gas lamps and over 5,000 electric lamps. In the streets 24,549 gas lamps and 4,218 electric lamps (including a few private lamps) are used.

A feature of progress during the year is the very close relation shown between improvements in lighting and traffic conditions. In the long list of improvements that have been made one finds frequent explanations based on the growth of traffic. Thus it is mentioned that the running of buses through streets previously free from passenger motor traffic has compelled the introduction of brighter illumination. Extra lighting has been provided at congested bus-stances (four-light instead of one-light gas burners being installed in some instances). In the new section of Renfrew Road, formed on account of the construction of the new dock, large electric lamps have been installed at the most dangerous points, and the number of points will be increased as the amount of traffic develops.

The great development of motor traffic has compelled attention to the erection and maintenance of traffic signs, and for the various islands now being erected at busy street junctions special lamps, bearing traffic directions visible by day and by night, have been designed and erected by the Department. Traffic signals have been taken over as part of the public lighting. Special lamps have been erected at all the fire-alarms in the city; these consist of an electric lamp in a ruby well-globe lettered "Fire" immediately over the alarm.

It is satisfactory to note that the General Strike had little effect on the activities of the Department, except for some delay in new work. No employee was absent from duty, and no restriction of the lighting was necessary.

The Annual Reports on Street Lighting in Glasgow are invariably interesting on account of the large mileage of streets, the special traffic problems, and the fact that both gas and electricity are widely used.

Proceedings of the Optical Convention

The full account of the proceedings at the Optical Convention, given in our last number, has aroused considerable interest, and we have received enquiries regarding the date of the publication of the official *Proceedings*. We now understand that it is hoped to publish the *Proceedings* not later than August 1st next, so that they should be available during the meeting of the British Association at Oxford. Owing to the large number of papers read at the Convention, and the consequent size of the *Proceedings*, it has been found necessary to increase the price, which is now fixed at 30/-, plus 9d. postage, instead of 25/-, as previously announced. Orders should be addressed to the Secretary, Optical Convention, 1926, 1, Lowther Gardens, Exhibition Road, London, S.W.7.

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

Some Notes on Electric Lamps No. 11

DAYLIGHT LAMPS

By W. J. JONES, B.Sc., A.M.I.E.E.
(E.L.M.A. Lighting Service Bureau).

IT is a well-known fact that the quality of the light emitted from artificial light sources is considerably different to that generally understood by the term "daylight." The difficulty, however, is to make definite comparisons, and this is rendered more difficult, due to the fact that the quality of daylight is varying every hour of the day and every day of the year. Furthermore, the quality of daylight from different parts of the sky is vastly different—direct sunlight being distinctly more red. In practice, however, when daylight conditions are referred to reference is made to north skylight, and a number of investigators, in particular Messrs. P. Ord and H. E. Ives, have made a number of tests on this basis, but in practice it is more useful to consider an average condition.

The passage of clouds across the sky materially affects the quality of the light, while the intensity of artificial daylight is an altogether problematic quantity. It is interesting, however, to note that the National Physical Laboratory in this country and the Bureau of Standards in America are obtaining measurements of the intensity of daylight throughout the year in an attempt to obtain some average figures, and if similar information on the quality of daylight could be obtained it would be possible to prescribe some form of standard for a particular country.

So far, the remarks which have been made refer entirely to the conditions which prevail in the open, and it must be borne in mind that there is a vast difference when we consider the amount of light which reaches the interior of a building. The nature of the windows, the orientation of the building all render the specification of general daylight intensities problematical.

Having made these reservations and general remarks on the subject, it is now proposed to deal more specifically with the daylight lamp and its application. The quality of light emitted from an electric lamp depends upon the material from which the filament is constructed in some small measure, but chiefly upon the temperature at which the filament operates. The higher the temperature the more the approximation to daylight, since there is a greater proportion of blue light emitted. In fact, an increase in temperature brings about a different distribution and intensity in various parts of the spectrum. The first involves a greater proportion of visible radiation, and, secondly, the intensity of the violet and blue radiations become immensely greater. This is clearly shown in Fig. 1. The lower curve shows the energy distribution from a light source operating at 2,000° while the upper one the distribution at 3,000°. It can be taken as a very approximate rule that average daylight consists of nearly equal proportions in the blue, green, and red sections of the spectrum.

The quality of the light from the gasfilled lamp is much nearer that of daylight, but it should be borne in mind that it is necessarily different in quality, due to temperature considerations. The sun, the source of daylight, has a temperature of approximately 6,000° C., and its light is therefore much more blue than that from the gasfilled lamp, the filament of which operates at approximately 2,700° C. This means that in order to obtain the right proportions of blue, green, and red light from a gasfilled lamp, the excess of red light in the composition of the light emitted must be filtered. It is for this reason that all methods attempting to produce artificial daylight necessarily involve a reduction in the amount of light available.

There are two general methods employed in these attempts. One depends upon reflection, as in the Sheringham daylight lamp, while the other relies upon the selective absorption of blue glass screens or the use of special blue daylight bulbs. In each case the blue and part of the green radiations are available, but the red is largely suppressed.

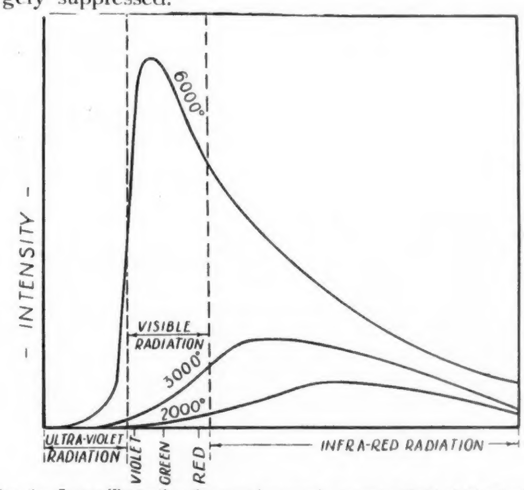


FIG. 1.—Curves illustrating the great increase in output of light obtained when the temperature of incandescent of the filaments is increased.

The daylight lamp is essentially a standard gasfilled lamp with a daylight blue bulb, which brings about this selective absorption, and represents an attempt on the part of lamp manufacturers to produce a source of light approximating in quality to that of daylight. The daylight blue lamp will be found to act as a suitable source of light in those industries where colour discrimination, and in some cases, colour matching, is important.

The daylight lamp for definite colour matching is being used in many situations, but in some instances failure has been entirely due to the fact that the intensity and the degree of diffusion of the installation is poor. How can one expect to obtain accurate matching when the intensity is only 3-4 foot-candles of artificial daylight used in the place of 25-30 foot-candles of actual daylight, or when in the case of artificial daylight the source approximates a few inches, while in the case of actual daylight the area is only limited by the size of the windows?

It is, therefore, suggested that instead of installing single daylight gasfilled lamps, multiples of these lamps should be used above a large diffusing screen, so that the area from which the light is emitted is extensive. In this manner colour matching is greatly faciliated, and the employment of this method of installation in factories and shops will do much to popularize the use of daylight lamps. In addition to the question of accurate colour matching, there is the wider matter of colour discrimination. Many industries and occupations which have no connection whatever with colour matching are now employing daylight blue lamps to assist in grading and the estimation of slight variations in the quality of materials. Below are given some typical instances in which these lamps are employed in this manner.

Daylight Blue Lamps at Collieries.—Lighting of picking belts: the quality of light obtained greatly facilitates the elimination of slate and similar material from coal.

Flour Grading, Examination of White Pigments and Tanneries.—One of the most difficult tasks to be accomplished at night-time is that of grading material which has a very slight difference in colour, such as the various whites of flour.

There are now a number of installations which are successfully employing daylight lamps to carry on this work after dusk; indeed, since the daylight lamp gives a light of definite quality, much more definite than that available during daytime, workers often prefer to operate under artificial daylight conditions all the time. The following trades also depend upon the ability to discriminate slight variations in colours in grading:—

Cigar manufacturers, tobacco, hop sorting, sorting tinplate and sheet metal.

Chemical works—precipitates.

Tanneries—leather grading.

Estimation of Colour.—In many instances it is important to have standards of colour which are not dependent upon the vagaries of daylight, and in such instances as tempering departments of steelworks, and the examination departments of isolation hospitals, the daylight lamp has proved invaluable. Furthermore, in a large laundry in the London area, the ironing department is completely equipped with daylight lamps, and it has been definitely shown that the number of complaints due to iron-moulds has been materially reduced. The worker can more readily detect the commencement of scorching under daylight lamps than under ordinary lamps.

Lamp Wattage.—It has already been pointed out that there is in all artificial daylight lamps an inevitable reduction in the amount of light which is available due to absorption, and many otherwise good installations suffer from the difficulty of insufficient intensity. As a very approximate rule it can be taken that at least double the wattage is required from these daylight lamps to give a similar amount of light that would be available from an ordinary clear lamp.

Women in Engineering

The current issue of *The Woman Engineer* contains a variety of articles by women engineers showing the diversity of work in which they are engaged. Amongst them may be noted "Women's Contribution to Metallurgy" (Christian M. Shaw Scott), "Electro-Farming" (Elsie E. Elmitt), and "Women as Factory Inspectors" (Constance Smith, late H.M. Chief Deputy-Inspector of Factories). Miss Elsie Elmitt is associated with Mr. R. Borlast Matthews in his work on electro-farming, and her contribution contains a summary of the experiments being conducted on the influence of artificial light on horticulture. We note that Miss Partridge is now installing electric light at Bungay, Suffolk, and that Miss Mary Dillon, who is President of the Brooklyn Gas Company, U.S.A., recently paid Headquarters a visit.

Reference is made to the Fourth Annual Conference of the Women's Engineering Society, to be held at Leeds University during September 3 to 6, and an account is given of the First Home Lighting Course, recently arranged for electrical saleswomen by the E.L.M.A. Lighting Service Bureau.

Electricity in the Service of Women

THE first annual general meeting of the Electrical Association for Women, on June 4th, served as a reminder of the growing importance of the part being played by women in electrical matters, particularly as agents in the movement for "better lighting." The meeting was followed by a luncheon, at which Lady Cowan presided. The toast of "Electricity in the Service of Women" was proposed by the Right Hon. Lieut.-Col. Wilfred Ashley, M.P. (Minister of Transport), who, as the Minister responsible for the prospective legislation on electricity supply, thus showed his recognition of the interest of this measure to the women of the country. In proposing the toast of the Association, Sir Hugo Hirst emphasized the great opportunities for women not only in utilizing electricity to lighten labour and brighten the home, but in carrying out the continual "service" which is an essential to electrical developments. Alderman Mrs. Hammer, in proposing the toast of "Our Guests," reminded those present that this was the first official birthday of the Association. It was thus a young body with, we trust, a prosperous career before it.

We are glad to observe that the E.A.W. is receiving influential support, for we have always believed that illuminating engineering offers a particularly favourable field for the services of women. The Illuminating Engineering Society from its inception has opened its ranks to women, and the writer some years ago contributed an article on "Illuminating Engineering as a Field for Women" to the journal of the Women's Engineering Society. It is not very long since one of the leading members of the E.A.W., Miss Partridge, read an able paper before the Society on the subject of shop lighting. As the writer predicted, there are now many women doing useful service for both gas and electrical undertakings as demonstrators, and in the recent demonstration of the lighting of the home by Miss Hodge at the E.L.M.A. Lighting Service Bureau members of the Society had an opportunity of judging for themselves the gifts of ladies for this form of work.

Since writing the above we have received the first copy of *The Electrical Age for Women*, the official journal of the Electrical Association for Women, edited by Miss C. Haslett. It is brightly written and is a creditable first number. Numerous greetings from public men and women are recorded, and a welcome to the journal is expressed by Mr. R. P. Sloan, President of the British Electrical Development Association. Mr. J. W. Beauchamp contributes an article on "How Electricity is Made," and Miss Florence Hodge deals with "Light for the Modern Home." There is also an account of the E.A.W. Luncheon, referred to above. Amongst the miscellaneous items we also notice a page for girl guides, written by Miss Margaret Partridge.

Electric Lighting in Subways

The part played by electric lighting on the tube railways is now so widely appreciated that the continual small changes and improvements are apt to escape notice. In connection with some of the new escalator systems much has been done, and there is general evidence of the tendency to eliminate glare in every possible way. The lighting of subways offers something of a problem, in view of the sudden change in brightness as a passenger emerges into the bright illumination outside; something might perhaps be done to alleviate the contrast by exceptionally powerful lighting near the exits. Incidentally one has an opportunity of observing, in certain subways near Liverpool Street, the comparative merits of bare lamps and shaded units. On a considerable length of the subways, bare lamps are still installed, but in part well-shaded lamps have been substituted. The much better effect of these, as one looks down the long passage and compares them with the bare lamps, is quite evident.


MAZDA
ELECTRIC
LAMPS
You take a new razor blade or a new cook for better or worse. You can't be sure which until you try. Thank goodness, when you put in a Mazda, you're always sure of good light
B T-H
2479A
Can be bought wherever electric lamps are sold.

The Lighting of an Operating Theatre

THE lighting of an operating theatre in a hospital constitutes a problem that has been receiving much attention during recent years. In view of the exacting nature of the work, a high illumination is necessary, and, what is at least equally important, the lights should be so placed and shaded that troublesome shadows caused by the body and hands of the operating surgeon must be avoided. Another consideration is the use of an illumination of approximately the same colour value as daylight, as much often depends on the recognition of discoloration of organs and tissues examined.

We have received from the British Thomson-Houston Co. Ltd. some particulars of an interesting installation designed to meet these requirements.

The two photographs reproduced on this page represent respectively a daylight and a night view of the operating theatre of the Rugby Infirmary. As will be seen from the daylight picture, the operating table is lighted by means of six B.T.-H. Glassteel Diffusers. Each unit is equipped with a 300-watt Mazda daylight gasfilled lamp. These six units are arranged in such a manner as to concentrate their light upon the operating table, which is illuminated to an intensity of about 80 foot-candles. It is, of course, impossible to give any idea of relative intensities in a photograph, and the night-time view of the theatre does not, perhaps, convey the impression of superabundant illumination.

The B.T.-H. Glassteel Diffuser is well known to all lighting engineers. It consists essentially of a Mazdalux Reflector, fitted with a glass diffuser which completely conceals the lamp and eliminates glare and deep shadows. A surgeon working under these units is able to take full advantage of the extraordinarily high degree of illumination without being at all handicapped by glare or uneven lighting. The daylight Mazda lamps provide light of such colour value that diseased tissues are quickly seen, and makes the surgeon's work less exacting.

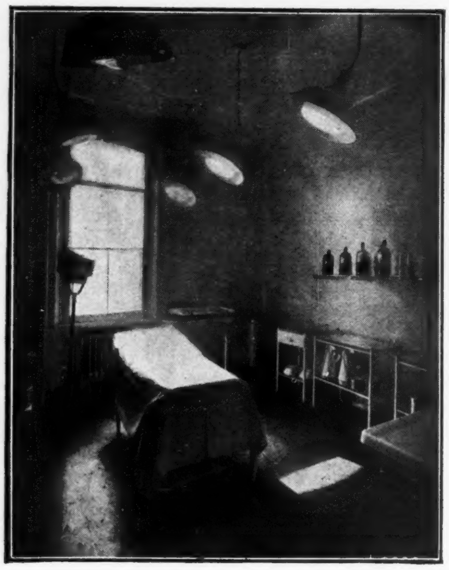


FIG. 1.—Daylight view of Operating Theatre in Rugby Infirmary showing disposition of the B.T.-H. Glassteel Diffusers employed for lighting the operating table.

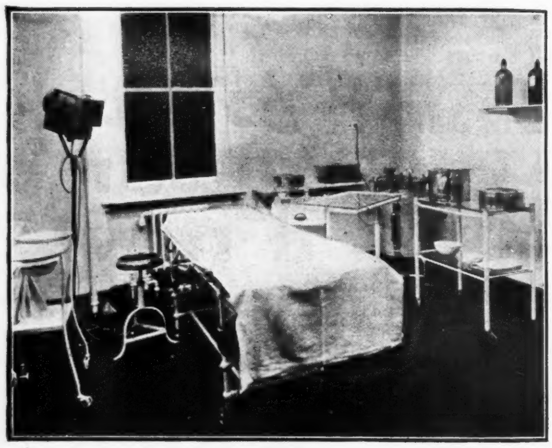


FIG. 2.—View of Rugby Infirmary Operating Theatre taken by the light of B.T.-H. Units. The intensity of illumination is about 80 foot-candles.

Sheffield Illumination Society

The members of the Sheffield Illumination Society visited the works of Messrs. John M. Moorwood Ltd., Stevenson Road, Sheffield, on the 9th June last. The party was conducted over the works by Mr. John M. Moorwood (Governing Director of the firm), and the whole process of melting, moulding, and casting of a lamp pillar and other castings of a kindred nature was shown and fully explained by Mr. Moorwood.

The lamp pillars are made of cast iron, which is produced by smelting iron ore in a blast furnace. The actual time occupied in casting a pillar is only about 18 seconds.

The visit to the works was the outcome of an invitation extended by Mr. Moorwood when he read a paper before the Sheffield Illumination Society on the 21st January last.

Mr. J. F. Colquhoun (Public Lighting Engineer), expressing the thanks of the members, said the visit had been most interesting and educative, and the Society was much indebted to Mr. Moorwood for the facilities which had been made for them.

Mr. Moorwood replied to the vote of thanks, and expressed the pleasure which it had been to show the members of the Society the various processes in the making of a lamp pillar.

We understand that the members of the Sheffield Illumination Society also visited Buxton on June 19th for their annual excursion this year. The journey was made by road, and a circular route was adopted, returning via Matlock Bath, where tea was served.

The party, which numbered about 60 members and friends, left Sheffield at 8-30 a.m. and had a stay of three hours at Buxton. At Matlock the gardens and boating on the river proved a great attraction, and a very enjoyable day's outing terminated on arriving in Sheffield about 9 p.m.

Sunlight and Health

The current *Bulletin of Hygiene*, issued by the Bureau of Hygiene and Tropical Diseases, as usual contains much varied and interesting matter. The special section on Light Therapy contains abstracts of numerous papers on the use of "artificial sunlight," some of which are illustrated. Of special interest is a contribution on the photometry of therapeutic lamps. Other sections deal with Town Planning, Industrial Hygiene, etc., and here again it is to be noted that photometric methods are being applied to the study of suspended dust, smoke and fumes.

Personal

We are informed that Mr. F. W. Fifield has resigned his position as manager of the Bristol Department of Messrs. The Edison Swan Electric Company Ltd.

Awards at the N.E.L.A. Convention

A recent issue of *The Benjamin Reflector* (Chicago) deals with the vast industrial lighting campaign organized in the United States. in which electric supply undertakings throughout the country took part. At the recent convention of the National Electric Light Association prizes were awarded to the organizations and geographic chairmen carrying off the honours in this activity. The three winners were: *First prize* (2,500 dollars), The Edison Illuminating Co., of Boston; *second prize* (1,500 dollars), Chicago Industrial Lighting Committee; *third prize* (1,000 dollars), Cincinnati Electric Club. The first prize for individual geographic chairmen was won by Mr. H. W. Derry, of the Union Gas and Electric Co. (Cincinnati).

The prizes were awarded on the following considerations: (1) Percentage of factories in communities brought up to a higher standard of lighting during the period of the Industrial Lighting Committee's programme from September 1st, 1925, to March 1st, 1926; (2) excellence of report based upon value to rest of industry in facts and figures; (3) evidence of an educational activity in industrial plants, i.e., increased production, fewer accidents, and less labour turnover.

The results achieved by the campaign in many cases were impressive. Thus the Edison Electric Illuminating Co., of Boston, was responsible for the sale of 30,000 reflectors amongst the 2,380 industrial plants on their lines, and the additional yearly income secured was 249,000 dollars (approximately £50,000) at an expense of 12,000 dollars (approximately £2,500).

A general tribute is paid to the more responsive and sympathetic attitude of the industrial concerns approached. From the beginning of the campaign the Benjamin organization took an active part, furnishing sales promotion material to a considerable number of supply undertakings, including the three prize-winners.

The whole campaign is an instructive illustration of the manner in which electric supply undertakings and makers of lamps and lighting appliances co-operate in the United States.

FIG. 1.—Swansea Corporation Offices floodlighted at night.

FIG. 2.—Cardiff City Hall floodlighted at night.

The Floodlighting of Public Buildings

We have several times drawn attention to the growing practice of illuminating the exteriors of public buildings by night. The two illustrations above, showing the application of G.E.C. floodlights and Osram gasfilled lamps for the floodlighting of the Cardiff City Hall and the Offices of the Swansea Corporation, are excellent examples.

Floodlighting in this country is making distinct progress. Applied in the first instance mainly to the exteriors of large stores and places of entertainment, it is now being extended to public buildings. Who knows but what ultimately the Houses of Parliament may not be illuminated in this way—in the same manner as the Capitol at Washington?

FIG. 1.—Night view of the interior of the main shop for groceries, vegetables, and meat of the Cowlairs Co-operative Society, Auchinairn, Scotland, showing four of the six gaslighting pendants which provide ideal shadowless illumination throughout the shop. The total hourly consumption of the six 6-light lamps is about 90 cubic feet of 470 B.Th.U. gas (0·43 therms), costing, with gas at 9d. a therm, slightly under 4d. per hour—a remarkably low figure for so perfect a piece of illumination.

Shop Lighting by Gas

Preparing for the Dark Season

DURING the late autumn and winter months the business-drawing capacity of a shop window and shop interior depends to no small extent on the brilliance, dignity and general attractiveness of its artificial lighting, for it must be remembered that many people who are at work during the daytime do their shopping after 5-30 in the evening.

Unless the shopkeeper is satisfied that his lighting installation already complies with modern requirements in this direction, there is little time to be lost in making arrangements for the equipment of the interior and exterior of his shop with a lighting installation which will, during the dark months, make an examination of the contents of the window a pleasure and the purchase of goods inside the shop a comfortable occupation.

Looking Ahead.—At this period of the year the planning and carrying out of a lighting scheme by the experts of the local gas undertaking can be done expeditiously, because the "rush" period which occurs after the first cold snap (when orders for the fixing of gas fires are coming in by thousands) has not arrived. That is our reason for giving practical suggestions in regard to interior and exterior lighting at a time when small shops, at any rate, need no artificial lighting at all. Installation work put in hand during the summer can be carried out with a minimum of inconvenience to the shopkeepers and to their customers.

A very fine example of up-to-date gas lighting has been installed in the shop of the Cowlairs Co-operative Society at Auchinairn, Scotland. A glance at the accompanying illustrations will give a fair idea of its real attractiveness. Situated as this shop is in a district in which housing is by no means ideal, and where the surroundings are somewhat dull and depressing, the brilliance of the exterior lighting and the beauty of the shadowless interior lighting of this shop attract the attention of all passers-by. Unfortunately it was not possible to take a photograph of this installation when there was a crowd inside, but that the shop does attract large crowds would be appreciated if a visit were paid to it at times between 4-30 and 6 on a winter evening. The extra large floor space to be seen in front of the counters is then closely packed with customers, and the sales are considerable. The photographs were taken at night-time between 9 and 11, in order that a fair impression might be given of the beauty and softness of the artificial lighting, the clearness with which every article exhibited in the shop could be seen, and the almost complete absence of shadows.

Lighting the Shop Interior.—Figs. 1 and 7 are views of the same interior, the one showing the grocery section, the other the meat section.

This interior is lighted by six pendants; each pendant has a cluster of six No. 2 size gas mantles and a superheater, the latter a device which utilizes the heat from the mantles for warming the gas-and-air mixture prior to combustion, thereby ensuring a considerable increase of light from the gas consumed. It will be noted that the lighting fitting adopted has a large white enamelled reflector above the mantles, and below a handsome semi-opaque bowl which shades the brilliant sources of light from the eyes of those in the shop and ensures at the same time a particularly even diffusion of light. While the illumination at eye and counter level is excellent, the ceiling and highest shelves are equally well illuminated, thus giving a proper impression of the roominess of the shop and enabling customers to see clearly and easily everything exhibited at points farthest away from them.

The Ventilating Properties of Gas Lamps.—The valuable ventilating properties of gas lamps are fully utilized in this installation, for it will be seen that small perforated gratings are provided in the ceiling above each

FIG. 2.—One 6-burner Gas Lamp, similar in design and size to those shown in Figs. 1 and 7, is used to illuminate the dairy of the Cowlairs Co-operative Society. Note the evenness of the illumination on the shelves and on the counters. The lighting of the interior of this shop costs less than ¾d. per hour for gas.

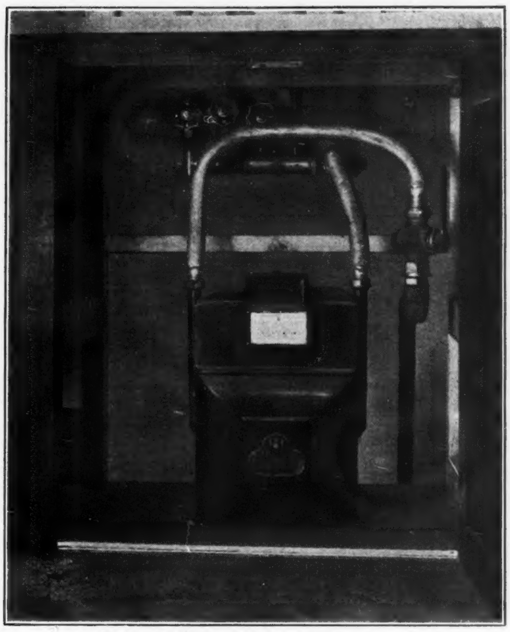


FIG. 3.—The Small Meter Cupboard, placed beneath one of the shelves in the shop, also houses three control cocks by means of which the lights in the interior of the shop and in the window are turned on or off. One cock turns on simultaneously all of the lamps in the window. The other two cocks turn on five of the lamps in the main shop.

pendant. This perforation facilitates the continuous exit of the up-currents of air from the lower portion of the shop caused by the heat of the gas burners. The steady entry of fresh air from the outside into the lower part of the shop is thus promoted. The air passing through these ventilating grids passes out into the open through a main ventilator fixed in the roof of the building.

Distant Control for Gas Lamps.—The lamps inside the shop are lighted and extinguished by the turning of three control taps, two of which are situated in the meter cupboard shown in Fig. 3, and one placed immediately inside the main entrance to the shop. The three lamps along the back of the shop are lighted up simultaneously by the turning of one control cock in the meter cupboard. The turning of the second control cock in the cupboard lights up or extinguishes two of the lamps in the front part of the shop. The third lamp in the front part of the shop is turned on or off by manipulation of a control cock placed near the door; thus any member of the staff is able to turn on the light as soon as he enters the shop or to turn it off immediately prior to leaving the shop. The third control cock to be seen in the meter cupboard is used for turning on or off the gas lamps which illuminate the shop windows.

Reliability of the Distant Control System.—The distant control system used is absolutely reliable, and can be used to light up and extinguish any desired number of lamps by the operation of a single tap fixed in the gas service at some convenient position. When the lamps are out of lighting, a by-pass jet in each lamp is kept alight by a small supply of gas which reaches it through the by-pass on the control cock, the service pipe, and the small device fitted immediately above the lamp. The usual arrangement made for the control of lamps in shops of the size shown is to have one cock to turn on or off the series of lamps lighting the windows, one cock to light or extinguish all lamps but one in the shop, and one cock (placed near the door) to turn on or off the remaining one interior lamp, for the use of the staff when paying visits of inspection to the shop at night-time, or when leaving the shop after it has been closed for business.

The Lighting of a Small Shop.—A lamp similar to those used in the main shop is used for lighting the

FIG. 4.—Night view of the windows of the main shop and of the dairy of the Cowlairs Co-operative Society, Auchinairn. Seven 3-light Gas Lamps in aluminium, with milk-white silica globes, are used for the lighting of these windows. These lamps are lighted and extinguished by the turning of one of the control cocks shown in Fig. 3. With gas at 9d. per therm, one hour's lighting of this fairly large shop frontage costs only 2¼d. for gas.

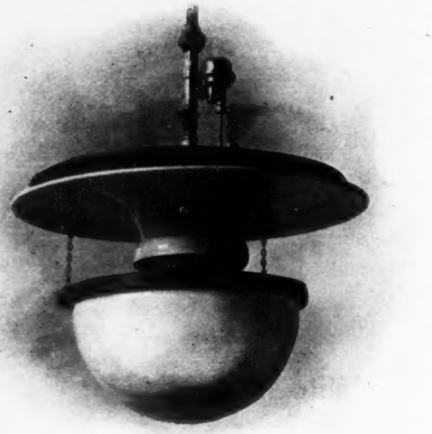


FIG. 5.—A close view of the Lamp as used for lighting the shop shown in Figs. 1 and 7. Above the lamp can be seen the small distant control device which enables the lamps to be turned on and off in series from the control cocks shown in Fig. 4.

adjoining dairy of the Cowlairs Co-operative Society. A view of the interior of the dairy is shown in Fig. 2. The even illumination on the counter and shelves is a noticeable feature.

The three back shops of the Society are also lighted by modern gas lamps, each fitted with a superheater, three No. 2 size gas mantles, and suitable shades for distributing the light to the points at which it is most required.

Shop-window Lighting.—Seven gas lamps are used for lighting the interiors of the windows of the main shop and of the dairy. A general impression of the effectiveness of the window-lighting installation can be gained from reference to Fig. 4. The casing of the window lamps is constructed in polished aluminium, and all of the brass parts are nickel-plated. A hinged door is provided to carry the heat-resisting milk-white silica globe which does so much to " soften " and diffuse the light. The silver-and-white effect of this lamp is very attractive, and makes it particularly suitable for the inside lighting of shop windows. Each lamp has a superheater and a cluster of three No. 2 size mantles. One gas-and-air regulator efficiently controls the supply of gas and air to the three burners.

The Use of One Size of Small Mantles.—It will be noted that all of the lamps used for the lighting of this shop are fitted with the same size of mantles. This facilitates the maintenance work, which is carried out efficiently and at a very low cost by the trained men of the local gas undertaking.

Suggestions for Shopkeepers.—Owners of small and medium-sized shops might well compare the results achieved in this case with those obtained in their own shops, and if their own lighting installations do not compare favourably with those shown they should immediately get into touch with the expert of their local gas undertaking, who will be able to make suggestions for the modernizing of their installations at reasonably small initial costs, and with little if any increase in the consumptions of gas; for it must be remembered that the latest gas lamps fitted with superheaters give a much higher efficiency for the gas they consume than the ordinary low-pressure gas lamp without superheater. It may be pointed out that the lighting of each shop and each shop window is an individual problem to be solved by individual attention if the best results are to be achieved. So varied are the individual requirements of shops that no standardized system of lighting can be recommended. Suffice it to say, however, that for each shop there is a modern gas lamp specially suited to meet its requirements.

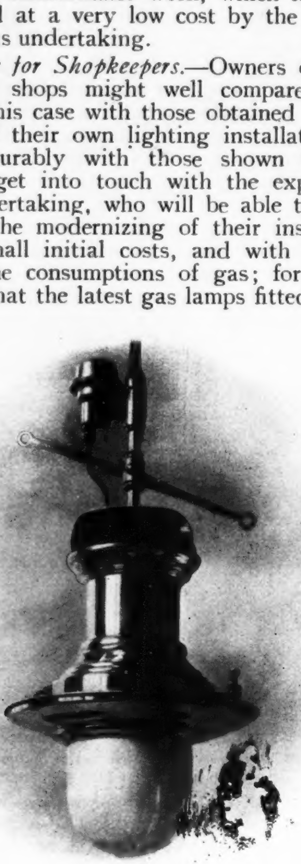


FIG. 6.—This type of lamp is used for lighting the shop windows shown in Fig. 4. The casing is of aluminium, and the globe is of milk-white silica ware. This is a particularly attractive lamp for the interior lighting of shop windows.

FIG. 7.—Another view of the main shop of the Cowlairs Co-operative Society, showing the meat section on the left. The Gas Lamps are turned on and off in series by means of control cocks, three of which are shown in Fig. 3. The lighting fittings are very dignified in appearance, and the use of the bowl beneath the mantles results in a particularly soft and pleasing light which shows off to their advantage the goods exhibited.

Appraising and Pushing Lighting Development

THE *Electrical World*, reviewing progress in illumination, agrees that artificial lighting is going forward by leaps and bounds. "But appraisal of this progress depends on the point of view. In retrospect this progress seems sufficient, even wonderful. But the student of artificial lighting realizes that only a good beginning has been made. To him its possibilities lie not only in the future but in the present. Those in the lighting industry may, therefore, look forward confidently to steady expansion; but this does not mean that they will enjoy all that present opportunities hold forth, unless all bend their shoulders to the work of development."

The advantages of adequate and proper artificial lighting have been well demonstrated in many fields, and the commercial possibilities are enormous. But our contemporary contends that there are still too many lighting interests that are content with natural progress, *plus* the acceleration of the relatively few pushers.

These remarks apply even more definitely to conditions in this country. Truly progress in illuminating engineering has been rapid. But can it be said that all those who derive direct commercial benefit from the movement are giving adequate support? The illuminating engineering movement is still dependent on the unstinted efforts of a relatively small number of active workers. The present progress might be far more rapid if all those interested would unite and put their shoulders to the wheel.

Artificial Lighting for Indoor Tennis Courts

THE artificial lighting of indoor tennis courts has long been a problem for illuminating engineers. It is, of course, a fairly simple matter to provide a high intensity of illumination on the courts. The difficulty lies in ensuring a reasonable degree of uniformity, and in this respect many installations in the past have notably failed.

An interesting example of tennis court lighting is afforded by the installation recently completed by Messrs. Duncan Watson & Co., at Westbury Manor, the residence of Sir Samuel Scott, Bt.

Indoor Tennis Court at Westbury Manor, lighted by Mazda lamps in B.T.H. Glassteel Diffusers. (Installation by Messrs. Duncan Watson & Co.)

This new installation designed by Messrs. Duncan Watson & Co., in collaboration with B.T.-H. Lighting Engineers, consists of eight B.T.-H. Glassteel Diffusers, each equipped with a 500 watt Mazda gasfilled lamp, the total consumption being 4 kilowatts. The illumination is, for all practical purposes, absolutely uniform over the entire court. The variation in intensity between any two points of the court, does not exceed 0·25 foot-candles, while the average intensity over the whole court is 10·1 foot-candles.

The comparison of this new system with the old method of lighting formerly adopted (with arc lamps) shows that by an increase of 21 per cent. in the current consumption it has been possible to increase the intensity of illumination by 150 per cent. The new lighting is entirely without flicker, and is a great deal more uniform than the old.

The B.T.-H. Glasteel Diffuser employed in this installation consists essentially of a Mazdalux type metal reflector fitted with a glass diffuser, and thus combines a very high efficiency of reflection with a uniform diffusion of the light and complete absence of glare.

The new lighting has added very considerably to the ease and accuracy of play and is in every respect satisfactory to the owner, Sir Samuel Scott. Further information may be obtained, by those interested in tennis court lighting, from Messrs. Duncan Watson & Co., of 62, Berner Street, W.1., or from the Lighting Engineers' Department, The British Thomson-Houston Co., Ltd., Mazda House, Newman Street, Oxford Street, W.1.

Electricity and Air Restore Gas Service

IN the *Gas Age Record* we notice an account of a somewhat unusual application of electricity and air to clear a tar stoppage in one of the gas mains of the Burlington (Vt.) Light and Power Co.

Winooski, a city of 6,000 inhabitants, is served by a low-pressure distribution system supplied through a three-inch high-pressure main from the Burlington gas plant, three miles away. About 10 o'clock on the morning of January 2nd, the office began to receive numerous calls of "no gas." The ordinary measures did not answer, and whilst the cause of the stoppage was not clear, evidently something had to be done quickly, as the entire community was in danger of being left without gas when it was needed most—during mealtime.

The line was uncovered at various points, tapped and fitted with risers. When the tap was made at the corner of Elmwood Avenue and Pearl Street the mystery was solved. At this point it was one-third full of solidified tar, the hardness of which resisted penetration with a knife. By installing pressure gauges at each of the openings we found the obstruction to be between this point and the corner of Pine Street and Pearl Street. This gave us about 700 feet of main, halfway between the plant and the governor house, to work on. Incidentally, this 700 feet was in a new asphalt street, laid last year, and to have opened it would have meant criticism from the city officials and the public.

A bank of A.C. transformers was set up between the two points mentioned and an electrical current of 400 amperes at 220 volts applied to the pipe, along with an air pressure of 80 pounds per square inch from a portable compressor. In less than an hour under this treatment the riser at the lower end commenced to emit a string of tarry matter which had evidently been warmed just enough to provide a sliding medium under this pressure. The pipe was then cut at this point, a section removed and the same treatment applied. During several hours a total volume of solid matter equal to approximately one-third of the total volume of the 700-foot section was discharged from the pipe at various intervals. Some pieces of solid matter 15 feet in length and equal in diameter to the size of the pipe were blown out. After making sure that the pipe was completely clear, the line was repaired, tested, purged and put into operation. The effects of this cleaning were soon noticed at the governor house in increased pressure and reserve during peak load. Without the simultaneous application of heat and pressure it is doubtful if the main could have been cleared except by working on much shorter sections which, as stated previously, it was desired to avoid on account of the newly-paved street.

TRADE NOTES & ANNOUNCEMENTS

LOCAL LIGHTING FOR DRAWING BOARDS, SEWING MACHINES, ETC.

In our last issue we referred to a neat unit for lighting sewing machines, introduced by the Photector Co. Ltd. A view of this unit is now shown in Fig. 1. It terminates in a cup-shaped reflector completely concealing the lamp from the eyes of operators; the actual reflector and lamp can be swivelled, whilst the arm carrying it can be moved up and down. The unit is thus fully adjustable, an essential quality for work of this class. In Figs. 2 and 3 similar units are shown in operation for the lighting of desks and drawing boards. In the latter case flexibility and adjustability are of considerable importance. Many draughtsmen prefer an adjustable local unit, which can be manipulated to suit the individual needs, to any form of general lighting. Local units of this kind have the great advantage that a high local illumination can be readily and economically obtained, and they are therefore serviceable for special cases of fine work. In adopting local lighting of this description two considerations should, however, be kept in mind. It is absolutely necessary that the actual source, being so near the operator, should be completely screened from his eyes. It is also desirable that there should be moderate general illumination in the room, so as to avoid troublesome contrasts between the brightly illuminated work and unduly dark surroundings. Subject to these conditions being complied with there is a good deal to be said for local lighting. A third consideration of importance is *adjustability*. This applies especially to fine detail work in which a high degree of craftsmanship is involved. The operator then often wishes to be able to twist and turn his light so as to vary the direction from which light is received. Many cases could be mentioned (for example, engraving on metal) where the direction from which light comes is of importance, and it may be necessary to alter this from time to time whilst the work is in progress.

FIG. 1.—General view of Fully-adjustable Local Unit, adapted for lighting sewing machines.

THE NEW HOLOPHANE LUMETER.

We have received from Holophane Ltd. copies of illustrated lists referring to the new model of the Holophane Lumeter. It may be recalled that while the basic principle remains the same, the instrument has been considerably improved in order to comply with the requirements of the B.E.S.A. Specification for Portable Photometers. The new model was described in this journal earlier in the year, on the occasion of its exhibit at the meeting of the Illuminating Engineering Society when the Standard Specification was discussed. It was also exhibited at the Optical Convention. Amongst the chief features of the new instrument are the inclusion of a voltmeter and regulating rheostat in the case, the redesign of the electrical connections in order to eliminate all possible errors through intermittent contacts, etc., and the addition of a special test-surface holder enabling the angle at which light is received from the source tested to be determined. The instrument is assembled in its case in a compact and convenient manner. With the aid of standard dark glasses values of illumination from 0 to 4,000 foot-candles can be measured, and, if desired, a special zenith attachment and standard daylight colour filter can be added to facilitate tests of daylight illumination.

FIG. 2.—Showing Adjustable Unit for lighting Drawing Board.

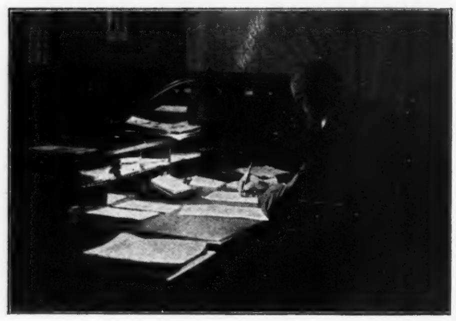


FIG. 3.—Desk Lighting with Local Unit.

THE DEVELOPMENT OF "RESTLIGHT" FITTINGS.

Reference has frequently been made in this journal to the "Restlight" glass developed by Mr. Lamplough, which is similar to that evolved by him for colour matching, but exercises less correction, so that the aborption of light is very much less. Whilst units utilizing such glass have better qualities for colour matching than uncorrected light, the chief advantage claimed for them is that they are, as the name implies, restful to vision, and reduce the effort of accommodation. We understand that this quality is already proving advantageous in the case of various kinds of work that are apt to be fatiguing to the eyes. Thus the system is being installed in the drawing office and the accounting and other departments in the Imperial Bank of India, in the drawing office and other rooms of the Acton Borough Council, and in the Hydrographic Section, where charts are drawn out, of the Admiralty, at Cornwall House. Another body making use of the system is the Ordnance Survey.

CONTRACTS CLOSED.

METRO-VICK SUPPLIES LTD. :

London, Midland and Scottish Railway (Stores Department); for "Cosmos" Vacuum Train Lighting Lamps.

Air Ministry; for three months from June 1st, for supply of "Cosmos" Carbon Filament Flashlight and Gas-filled Lamps.

London County Council (Supplies Department); for "Cosmos" Opal Bulb Gasfilled Tramcar Lamps.

A SHEFFIELD LANDMARK.

Night View of Floodlighted Sign over the Sheffield Premises of The British Thomson-Houston Company Limited.

The Sheffield showrooms of the British Thomson-Houston Co. Ltd. are distinguished by a very effective sign. This sign, which naturally and inevitably advertises Mazda Lamps, is a skeleton opal letter sign illuminated by means of two B.T.-H. floodlight projectors. As will be seen from the photograph, the sign does not suffer from any lack of legibility, and, indeed, provides convincing evidence of the effectiveness and economic advantage of the floodlighted signs. To get a comparable effect by any other means would involve a very much greater consumption of current, and also a certain amount of glare which would naturally decrease the visibility of the sign.

The Mazda sign over the B.T.-H. premises in Campo Lane, Sheffield, is a landmark for all electrical dealers in the neighbourhood. For them it signifies a lighting service and a selling organization of outstanding value.

"VITAGLASS" AND CHICKEN-HATCHING.

Many things are hoped from the new "Vitaglass," which has the property of transmitting a wide range of ultra-violet radiation, checked by ordinary window glass, which is considered valuable to health. Experiments have been made with such glass for rearing plants, and it is expected that results will show a marked improvement over those obtained in ordinary greenhouses. Experience of plants raised in alpine and hilly districts, where ample sunlight is available and the light is specially rich in ultra-violet light, leads to the belief that the ultra-violet radiation plays an important element in horticulture.

A still more novel prospect, however, is the application of this glass to chicken-rearing. According to some information put before us, recent tests have given encouraging results. Two lots of chickens were reared under identical conditions, except that in one case ordinary glass and in the other "Vitaglass" was used. The lot raised under the "Vitaglass" are exceptionally healthy and "excel the first lot in liveliness." In spite of their being younger they have gone out earlier than the others, and prefer the grain and green food, whereas the chicks raised under ordinary glass preferred the invalid diet of dry mash mixed with cod liver oil. This latter observation seems in line with the theory of medical experts that exposure to ultra-violet rays produces results similar to nourishment with cod liver oil, and in some way replaces the need for this special fatty food.

SIEMENS ELECTRIC FITTINGS.

Catalogue No. 150, just issued by Messrs. Siemens and English Electric Lamp Co. Ltd., shows a great variety of wall brackets, hall lanterns, electroliers, dining-room pendants, table and floor standards, etc. A special feature is the array of silk shades, whilst some of the pleasing designs of glassware for dressing-room pendants, etc., show a marked advance on those customary a few years ago.

"ELECTRICAL CONTRACTING."

We understand that a book on the above subject, by Mr. H. Ayres Purdie, is now being issued by Messrs. Benn Bros. Ltd. The book appears at an opportune moment and contains full information on the preparation of costs sheets, estimates, specifications, and should therefore be of considerable interest to contractors throughout the country.

REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

THE PROBLEMS OF ARTIFICIAL ILLUMINATION, IV; INVISIBLE RADIATION FROM ILLUMINANTS; *issued by the Research Laboratories of the General Electric Co. Ltd.*

This leaflet contains a review of data on the spectra of incandescent bodies and various illuminants, reference being made to the work of Coblentz, Luckiesh, and other American investigators. The leaflet is issued by the G.E.C. Research Laboratories, and the names of those responsible for much of the tabular data are not mentioned. One would like to know the names of the investigators in this country. The data, however, are used to support the conclusions arrived at in the familiar researches of Professor Verhoeff and the late Dr. Louis Bell, to the effect that the danger of injury to vision through ultra-violet rays emitted from incandescent lamps is remote. This conclusion is no doubt correct, though it is naturally one that needs the authority of a physiologist. There is no justification for alarmist views on this point, as was demonstrated by Mr. Gaster and other members of the Illuminating Engineering Society in the course of a discussion before the Royal Photographic Society some years ago. One is inclined to think, nevertheless, that insistence on this point is rather out of date. At the present time much interest is being taken in the general beneficial influence of ultra-violet rays on health, so that sources entirely destitute of this form of radiation are not necessarily at an advantage. In actual fact, as the recent researches of Professor Fabry have proved, the quality of invisible radiation emitted by an incandescent lamp is considerably affected by relatively slight variations in the composition of the glass bulb. The fact that incandescent lamps with quartz bulbs have been prepared for therapeutic work suggests that the amount of ultra-violet energy obtainable from an incandescent filament is not necessarily negligible, though doubtless the proportion of very short-wave radiation is minute.

THE SOCIETY OF ARCHITECTS; *by C. McArthur Butler.*

This little book by Mr. Butler contains a readable review of the work of the Society of Architects during the period 1884-1925. Mr. Butler himself has been officially connected with the Society since 1898, and has done a great deal for its members. Its first secretary, Mr. G. A. T. Middleton, was an early contributor to *The Illuminating Engineer* on architectural aspects of lighting. The Society of Architects has now, by agreement, entered into amalgamation with the R.I.B.A., and no doubt this fusion of interests is for the benefit of the architectural profession. One must, nevertheless, pay tribute to the spirit of independence that led originally to the formation of the Society of Architects, and to the efforts which enabled this body, from small beginnings, to make a position for itself and do so much useful work. Mr. Butler has done a good service to the Society by putting on record this account of its existence, which should be treasured by all its members.

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